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JUNE 1956

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JUNE

From "The Vision of Sir Launfal"

JAMES RUSSELL LOWELL

Over our manhood bend the skies;
  Against our fallen and traitor lives
The great winds utter prophecies;
  With our faint hearts the mountain strives;
Its arms outstretched, the druid wood
  Waits with its benedicite;
And to our age's drowsy blood
  Still shouts the inspiring sea.

Earth gets its price for what Earth gives us;
  The begger is taxed for a corner to die in,
The priest hath his fee who comes and shrives us,
  We bargain for the graves we lie in;
At the devil's booth are all things sold,
Each ounce of dross costs its ounce of gold;
For a cap and bells our lives we pay,
  Bubbles we buy with a whole soul's tasking:
'Tis heaven alone that is given away,
  'Tis only God may be had for the asking;
No price is set on the lavish summer;
June may be had by the poorest comer.

And what is so rare as a day in June?
  Then, if ever, come perfect days;
Then Heaven tries earth if it be in tune,
  And over it softly her warm ear lays;
Whether we look, or whether we listen,
We hear life murmur, or see it glisten;
Every clod feels a stir of might,
  An instinct within it that reaches and towers,
And, groping blindly above it for light,
  Climbs to a soul in grass and flowers;
The flush of life may well be seen
  Thrilling back over hills and valleys;
The cowslip startles in meadows green,
  The buttercup catches the sun in its chalice,
And there's never a leaf nor a blade too mean
  To be some happy creature's palace;
The little bird sits at his door in the sun,
  Atilt like a blossom among the leaves,
And lets his illumined being o'errun
  With the deluge of summer it receives;
His mate feels the eggs beneath her wings,
And the heart in her dumb breast flutters and sings;
He sings to the wide world and she to her nest—
In the nice ear of Nature, which song is the best?

That jewel "knowledge" is great riches, which is not plundered by kinsmen, nor carried off by thieves, nor decreased by giving.—
BHAVABHUTI.

CONTENTS FOR JUNE, 1956

WORKSHOP ON THE USE OF RADIOISOTOPES IN SCIENCE TEACHING

A two-week Workshop on the Use of Radioisotopes in Science Teaching will be held again this summer at Iowa State Teachers College, Cedar Falls, Iowa, June 18–30, 1956. It will be conducted under the direction of the Science Department of the College. The local staff will be augmented for lectures and consulting purposes by visiting scientists who are authorities in the field of nuclear energy and radioisotopes.

This is the second such Workshop to be held by the College in its attempt to meet the needs of high school teachers and teachers of beginning college science courses by providing them first-hand acquaintance with radioisotopes. The Workshop is planned with the idea that the use of radioisotopes for this purpose is both practical and safe. Lectures, audio-visual aids, individual study, and laboratory work will be used to present the subject. Each participant will obtain direct experience with instruments and radioisotopes through daily laboratory work. Considerable attention will be given to developing experiments suitable for use by each teacher in his or her teaching position.

Enrollment in the Workshop is restricted to twenty-four participants in order to provide proper laboratory experience for each.

Grants by individual firms have made possible the offering of a limited number of scholarships.

Married teachers are invited to bring their wives. Housing for both will be available in one of the men's dormitories. Early reservations are advised as there will be another institute group on the campus at this time and the number of such accommodations are limited.

Address your inquiries to J. W. Kercheval, Science Department, Iowa State Teachers College, Cedar Falls, Iowa.

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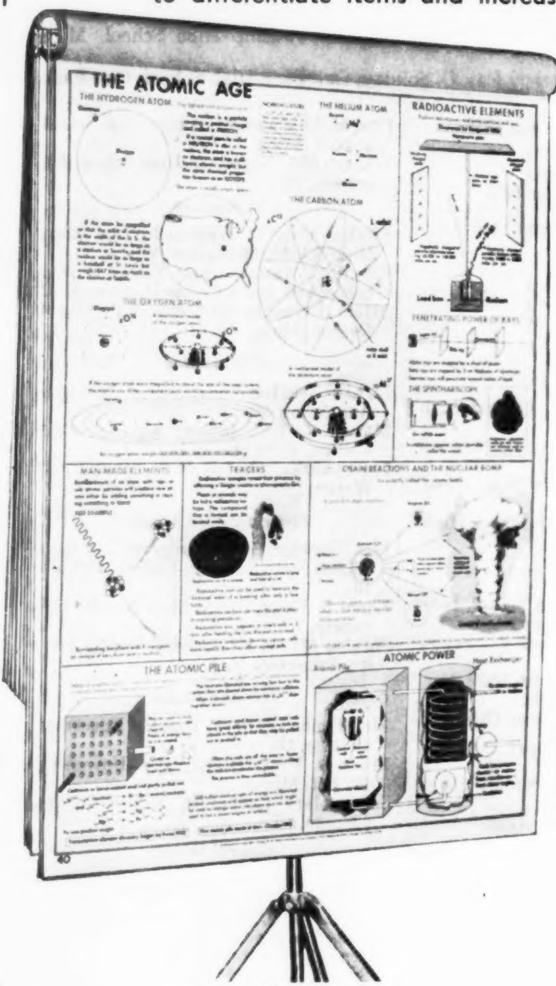

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SCIENCE DEMONSTRATIONS FOR ALL LEVELS*

LAWRENCE A. CONREY
University of Michigan, Ann Arbor, Mich.

A science teacher at any level is often confronted with the problems of illustrating basic principles in ways that are concrete. In the constant search for more understandable, concrete explanations, illustrations are desired which are a stimulation to the senses and more closely associated with the experiences of the pupils involved. This is particularly true of those explanations which involve tiny particles, including those of molecular or sub-molecular size. The pupils cannot *see* what is assumed to be occurring so it must be interpreted for them.

The following three demonstrations are of this type. They involve simple common materials. The fact that pupils encountered difficulty with other means of explanation was responsible for their development. The author has had the opportunity to use them at all age levels from fourth grade children to college graduate teachers and the response has been equally enthusiastic. They have helped to reinforce the need for simplicity of explanation, regardless of age level, if standard methods of explanation do not produce functional understanding.

I. RELATIVE HUMIDITY AND RAIN

a. *Materials:*

Collapsible travel cup, water.

b. *Procedure:*

Open the collapsible cup to the fullest extent. The author has en-

* From General Science Section of the Central Association of Science and Mathematics Teachers, November 24, 1955, Detroit, Mich.

countered an impression that these cups are no longer available but, actually, many stores still sell them. Fill the cup approximately one half full of water. Explain that the entire cup represents the maximum quantity of water that a volume of air could contain if saturated at a certain temperature. Show that the cup is only half filled with water. Thus, at the present time, this "air" is only holding one-half of what is possible for it to hold. It has a "relative humidity" of only fifty per cent.

However, as the air becomes colder, the amount it can hold is reduced. To illustrate this, release the top section of the cup and let it fall to the base. Thus, the total amount of moisture that this "colder air" can hold is reduced. Since the total capacity of the cup has been reduced, the initial amount of the water now occupies a larger portion of the cup and the "relative humidity" has been increased.

Next, hold the cup fairly high above the floor and continue to "cool the air," with the resulting decrease in moisture capacity of the air, by releasing another section of the cup. It is evident that, in diminishing the size of the cup, the amount of water it does hold will soon exceed the amount it can hold and the excess will "rain" on the floor.

II. Rapid Fluid Flow Parallel to a Surface and Reduction of Pressure

a. *Materials:*

Small enclosed box, collection of corn or bean seeds or other small object, several students to serve in a role-playing capacity.

b. *Forward:*

From the title above is it probably evident that the basic concept involved here is what is generally known as Bernoulli's principle. It is not at all difficult to draw, from everyday life, applications of the principle. The atomizer, sensation of a driver of a car in passing a truck coming from the opposite direction, the curve of the baseball etc. are all examples of the effect produced. The instructional problem is to find an explanation that pupils will understand and accept regarding *why* the rapid flow results in a reduction of pressure. The following explanation was devised to provide a simple direct answer to this problem.

c. *Directions:*

Place the seeds inside the box and shake it. The collisions of the seeds with the side of the box is naturally heard. This permits the comparison of the seeds with molecules of a gas. These collisions of

the "moving molecules" with the sides of the container illustrate how they exert a force. They push on any object that attempts to stop them because of their momentum.

Next, call for three or four pupils to come forward and ask them to arrange themselves side by side facing the remainder of the group. Walk slowly in front of this group being certain to reach out and touch each one as you pass. Repeat this procedure several times moving increasingly rapidly each time and show that it becomes increasingly difficult to touch each one as the speed parallel to the group is increased.

Announce that the line of pupils are now to represent the side of an airplane in flight. An airplane in flight has a stream of air moving more or less parallel to the side of the plane. The more rapidly that the plane moves, the more rapidly this air stream moves.

If the molecules of air outside the airplane push on the sides of the plane by their collisions with it, the faster they move in a direction parallel to the plane, the less will be their opportunity to collide with the side. The fewer the collisions, the less will be the push or pressure against the side.

Next, place yourself behind the line of pupils. You are to represent a passenger within the plane. Ask the two pupils directly in front of you to move apart so that there is an open space. This open space can represent a door of the plane that has fallen off in flight. The air that is on the outside is rushing by so fast that it does not have time to collide with the front of the person near the door a sufficient number of times. Thus, the push of this air on the front of the person is reduced. The molecules of air within the plane are not "in a hurry" and they collide with the person a normal number of times. The greater number of "pushes" from behind causes the person to be pushed out of the door.

The choice of illustration has been based on experience in teaching the concept. The incidents when an accident of this type has occurred in flight seem to be well known.

III. Energy Transfer Resulting from Impact, Heat Conduction, Sound, or Electrical Potential

a. *Materials:*

Two yard or meter sticks, nine to twelve marbles.

b. *Forward:*

The following demonstration is often used to illustrate Newton's Third Law of action and reaction. In reality it does not truly illustrate this. Rather, it demonstrates the effect of transmission of an

action. The demonstration itself is not new. It is included here primarily to indicate the wide variety of applications to which it can be put.

c. *Directions:*

Place the two yard or meter sticks parallel to each other with an interval between them. The size of the interval will depend upon the size of the marbles available, since the marbles will rest upon the top of the sticks on the groove created. Marbles approximately one inch in diameter are more desirable because they are heavier and more easily controlled.

Arrange the marbles along the groove between the sticks so that they are in a line touching one another. Remove one marble and roll it with some force toward the line of marbles. When the marble makes contact, one marble will move away from the opposite end of the line. If the operation is repeated with two marbles, two will move away from the opposite end. The effect will continue with the use of an increased number of marbles on initial impact.

Next, remove one marble from one end and two from the other. Roll this number from opposite ends so that they will arrive as close to the same time as possible. The number of marbles moving away from each end will be the same as the number used at the opposite end for initial impact.

d. *Applications:*

(1) *Air pressure as created by impacts of moving molecules.* This illustrates, quite dramatically, the "push" created by the attempt to stop a moving object

(2) *Electrical electron flow in a conductor.* Conducting wires are actually filled to capacity with electrons. Electron "flow" can be considered as an electron "hopping on" one end of a wire, "giving a push" which causes an electron to "fall off" the other end.

(3) *Spacing of molecules and the conduction of heat.* Since conduction is considered a molecular contact type of heat transfer, this device illustrates very well how conduction takes place. The line of marbles can be separated from each other and the less efficient transfer of energy can be illustrated. This would correspond to the influence that spacing of molecules in the different states of matter has on conduction.

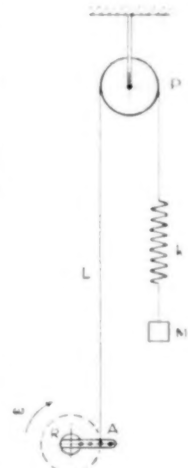
(4) *Successive compressions and sound travel.* Each marble is moved away by a separate impulse traveling the length of the marble line. If several marbles are moved away, there were several impulses traveling the length of the marble line. If a pupil touches a marble in the line lightly with the tip of the finger, the rapid succession of im-

pulses can be detected. This can be associated readily with a rapid succession of compressions traveling through a conducting medium from a vibrating body. The technique described above of creating an impact on both ends of a marble line simultaneously can be used to illustrate the "passing" of compressions from opposite directions.

A DEMONSTRATION OF FORCED VIBRATION AND RESONANCE

Julius Sumner Miller
El Camino College, El Camino College, California

Free vibration without damping (or reasonably so) is easily demonstrated by the harmonic motion of a loaded spring vertically supported. The logical sequence to this topic is that of *forced* vibrations in which a disturbing force acts upon the vibrating body periodically. As a consequence the frequency and amplitude of the original natural motion are affected by the frequency and amplitude of the disturbing force. When the impressed frequency (f_i) is equal to the natural frequency (f_n) resonance exists. The *effect* of the disturbing force on the maximum displacement can be shown to be



$$\frac{1}{1-f_i^2/f_n^2}$$

where f_i is the impressed frequency and f_n is the natural frequency. That is, the amplitude of the free vibration is multiplied by this fraction. Physically, the amplitude grows as f_i approaches f_n. The arrangement shown in the accompanying figure permits the demonstration of these effects. P is a friction-free pulley. R is the chuck of a rotator to which is fixed an arm A. To this arm a swivel peg is attached which permits rotation on its own axis. Variations in the amplitude of the driver are thus provided. The circular frequency of the impressed force may be controlled with the friction clutch on the rotator. The string L should be *very* long compared with the radius at A. Excellent qualitative results are obtainable if the natural period of the mass on the spring is fairly long—a second or more—and the amplitude of the driver a few centimeters.

Note: I am indebted to my colleague Dr. F. E. Deloume for preparation of the drawing.

AN EASY DOES IT

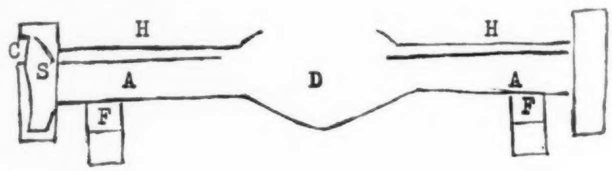
GEARS FROM THE JUNK YARD

REBECCA E. ANDREWS
Woodrow Wilson High School, Washington 16, D. C.

The rear end of an old automobile found in a junk yard and mounted in the physics classroom can do much to bring about an understanding of the differential. It also enlivens classroom discussion.

And while the rear end is mounted, the wheel cylinder and brake shoes of the hydraulic brakes on one of the wheels may be exposed to view and the operation of the hydraulic brake mechanism clarified.

The mounting is shown in the figure. The axle is A; the differential is D; the wheel brake cylinder is C; the brake shoe is S; the hydraulic lines are H; and the cinder blocks are F.



GM CONTRIBUTES TO THE UNITED NEGRO COLLEGE FUND

A $35,000 gift by General Motors to the United Negro College Fund was announced by Harry W. Anderson, GM vice president and chairman of its committee for educational grants and scholarships.

The grant was a part of General Motors' expanded program of support for higher education and brings to more than $100,000 the amount GM thus far has contributed to the United Negro College Fund which aids 31 Negro colleges in 12 states.

Francis A. Kornegay, assistant executive director of the Detroit Urban League and Detroit representative of the Fund, expressed appreciation to Mr. Anderson for the gift, and called it "the largest received from any corporation in the country."

Mr. Anderson declared that General Motors "welcomes the opportunity to support the United Negro College Fund whose member colleges produce a majority of America's outstanding Negro leadershlp."

"The 23,000 Negro students enrolled in colleges aided by the Fund are part of America's greatest promise for the future—its youth." Mr. Anderson said.

Kornegay said the money will be used by member colleges for scholarship aid to promising students, increasing teacher salaries, and expansion of library and laboratory facilities.

The General Motors' $5,000,000 program of support for higher education is now in its second year. Besides yearly grants to associations of colleges, the plan, when in full operation, will have 1,400 outstanding young men and women each year studying under four-year scholarships in colleges of their choice.

A STUDY OF REMEDIAL ARITHMETIC CONDUCTED WITH NINTH GRADE STUDENTS*

ALLEN BERNSTEIN
Cody High School, Detroit, Michigan

PART II: TEACHING METHODS AND CASE STUDIES

The problem of teaching remedial arithmetic in the public high school has existed for many years. Large numbers of students are admitted annually to the public high schools who are deficient in some (often many) of the skills and understandings of basic arithmetic. Much experience with this problem has been gathered by teachers during the last three decades, mostly in the elementary schools. Under the sponsorship of Dr. C. L. Thiele, supervisor of mathematics instruction for the Detroit Public Schools, and Mr. Herman G. Schumacher, principal of Cody High School, Detroit, the author carried out such a large scale study at Cody High School. Many activities took place during a two-year period of the study. The purpose of this article is to describe the teaching methods used in both large classes and small "clinic" groups.

The first teaching phase of the study, begun in September, 1953, utilized the classroom situation as a means of presenting special practice material designed to aid in the correction of common errors found on the Cody High School Diagnostic Arithmetic Test. The test had been previously administered to 523 entering ninth grade students. The second phase saw the establishment of teaching clinics, each with six students, who were instructed by wholly individualized methods.

1. THE CLASSROOM TEACHING EXPERIMENT

Special exercises were prepared by the author, based on the common diagnostic items found on the Diagnostic Test. These were supplemented by an arithmetic workbook,[1] typical of many available to schools today. These materials were the basis of approximately one third of the class work of the semester.

The general procedure was to ask the students to do the first three problems in the exercise, and check answers before proceeding. The purpose was to enable the student to find out if he had been doing the computation correctly. A large number of students in the class usually made errors in the first three problems. The teacher then demonstrated on the chalkboard both the common wrong procedures,

* This is a sequel to an article appearing in the January 1956 issue of SCHOOL SCIENCE AND MATHEMATICS entitled "A Study of Remedial Arithmetic Conducted with Ninth Grade Students."

[1] *Mastering Basic Arithmetic*, by Lyons & Carnahan.

which were assumed had been used, and the correct procedures. There were generally some students in the class who volunteered to assist in explaining what was wrong with the incorrect procedure, and how the correct method worked.

There are many teachers who would object to the procedure of showing a wrong type of solution on the chalkboard on the grounds that negative methods are a poor approach to teaching. If the subject matter were being presented to fourth or sixth grace students for the first time, the author would agree heartily. The ninth grade students had been exposed to the subject matter many times, had expressed boredom and disgust with it, and, in many cases, thought they had an adequate knowledge of it. Many students were quite oblivious of the fact that the procedures they were using were wrong, and attributed their incorrect answers to errors in computation, rather than understanding and procedure. The device of showing the incorrect procedure served two purposes. One was the attention-getting value for the student, who was surprised to find that his incorrect solution had been duplicated. The other purpose was to facilitate meaningful explanation of the correct solution.

Corrective exercises are no better than the teaching method used to present them. In general, the method of explanation was based on a meaningful approach to the problems of the number system. For example, it is possible to explain multiplication problems involving zero by saying that you place a zero under each zero in the multiplier, and proceed to the next place. It is also possible to say that when you multiply three hundreds by six tens, the result is twelve thousands and, therefore, the two is put in the thousands place. In view of the vast volume of research which had been developed concerning a meaningful approach to arithmetic, the author assumed the superiority of the latter methods and used them as often as possible in presenting these materials. While the statistical results of the study could not be used to support this belief, many remarks made by students, added to qualitative observations made by the author, appear to justify the choice.

The two examples which follow illustrate common deficiencies and the special practices designed to aid in their cure:

1. Problem: 4.13+8.287+19

Wrong solutions commonly found:

4.13	4.13
8.287	8.2 87
19	19
12.607	8 7.19

Since few textbooks have more than a small number of such problems for student practice, lessons involving addition and subtraction of decimal numbers were prepared, each with twenty problems, and used as class practice after adequate explanation.

2. Problem and solution:

```
  405
 ×308
 ----
 3240
1215
 ----
15390
```

It is clear, upon examination of the wrong solution, that the student mistakenly placed the result of multiplying three hundreds by five ones in the tens place instead of the hundreds place. Multiplication by the zero in the tens place of 308 was ignored. Special practices of ten problems, in which all numbers contained one or more zeros, were prepared to aid in this teaching problem.

This description is not intended to give the reader the impression that the kinds of problems described do not appear in standard classroom materials. The difficulty lies in the fact that the problems were mixed into other exercises, generally labeled "Review." This type of text organization tends to mask the deficiency. A student with a particular deficiency may still have an achievement score of seventy to eighty percent on a classroom exercise. Since the teacher may consider the score to be "passing," the deficiency may never be dealt with.

Many behavior patterns, properly classified as deficiencies, but much rarer in incidence, were not treated in this manner. In this classroom teaching experiment, these items were not touched, or were dealt with only incidentally. For example, an occasional student would solve a subtraction in the following manner:

```
 7 89
90,000
  -825
------
97,075 or 87,075
```

Note that the student's conception of borrowing was to reduce each successive place in the minuend by one more number.

To aid in evaluation of the classroom experiment, the Cody High School Diagnostic Arithmetic Test was given to the Remedial Arithmetic Classes as a final examination at the end of the semester. A

sample of fifty-five students, who had completed the initial and final examinations, was obtained.

In order to establish a control, the same test was given to two classes in General Mathematics II at the beginning of the following semester. The students in these classes had come from the classes of six different teachers, thus reducing the possibility that a differential between the experimental and control groups would be attributed to the teacher factor. A control sample of forty-eight was obtained.

The mean gain for the experimental group was 13.9 points, a highly significant gain. The mean gain for the control group was 1.2 points, which was not statistically significant.

2. The Clinical Teaching Experiment

During this phase of the study, students, classified as remedial in arithmetic, were excused from their regular large mathematic classes, to attend a Mathematics Clinic in groups of five, six or seven, for individualized instruction. The students selected were limited to entering ninth grade students in Remedial and General Mathematics. The criterion used, at first, was a score on the Iowa Every Pupil Tests of Basic Skills, Part D, of 6.2 or less. Later, other criteria, such as a score of less than 50 on the Diagnostic Arithmetic Test, or the request of the classrom teacher to examine a case of potential failure, were used. The period of instruction was flexible. Students attended the Clinic as little as one day, or as much as the entire semester. When instruction was completed, the student was returned to his originally scheduled class and another student was sent to the clinic. The project was evaluated for two semesters, after which the procedure was established as a permanent part of the school program, although research data was no longer recorded. During the second semester, a careful attendance record was maintained for each case, and the number of actual lessons was recorded. The mean attendance for 59 cases was 17.2 lessons. This figure is somewhat misleading, since one would judge that the "average" student could be instructed in about three and one half weeks. A week must be added to this figure, because of irregular attendance, a common phenomenon with such children.

After the two semesters, a total of 81 cases were listed as completed, and 11 not completed for various reasons.

The causes of arithmetic deficiencies can be broadly classified in two general areas:

1. Gaps in previous understanding or instruction.
2. Personality problems, including physical, emotional and socio-environmental factors.

The case studies following are presented to illustrate some of the prominent patterns learned from the study:

a. *Gaps in Instruction Responsible for Deficiencies:* If the case is not complicated by emotional or other personal factors, it is generally not necessary to examine the causes of the deficiency. It is enough to treat the symptoms by teaching the student what he does not understand. Consider the case of Lela:*

Lela was a rather mature girl for her age. She was poised, reserved, but not to the point where one would consider her excessively shy and withdrawn. She was neat, well-groomed, and considered a good citizen by all of her teachers. In our contacts with her outside of class, she seemed to have her normal quota of friendships. In short, she appeared a normal adolescent, with no apparent emotional problems which would complicate learning. She exhibited the following deficiencies:

a. Copies own numbers incorrectly.
b. Omits decimal points in addition.
c. Misunderstands nature of decimal point in problems like 7.1+3.15+16.
d. Fails to reduce fractional answers to lowest terms. (Lela told the teacher that she would know how to do this, but had misunderstood the directions on the test.)
e. In multiplication, does not use zero correctly with numbers ending in one or more zeros.
f. In dividing fractions, inverts the dividend fraction instead of the divisor.
g. Does not borrow correctly when subtracting denominate numbers.

Lela showed a very quick grasp of the principles involved in each of the deficiencies listed which required instruction. (Items c, e, f, and g.) It was only necessary to explain the items once and to assign a short practice of ten problems for each, which she immediately completed without error. Five days after instruction began, she took another form of the Diagnostic Arithmetic Test and scored eighty one points out of eighty seven. The six points she lost were due to random errors.

b. *Cases Due to Other Factors than Low Achievement:* In this situation the deficiency is generally due to personality factors and has little or nothing to do with a lack of understanding of arithmetic processes. In such cases the approach is two-fold. The instructor must, in an objective manner, show the student how his behavior is the cause of his low achievement and to utilize whatever learning deficiencies may exist, however few, as a means of exhibiting helpfulness and willingness to teach. In such cases the pupil-teacher relationship is the primary factor in the improvement. Consider the case of Leonard L:

Leonard was a slender boy of fifteen, who presented to the casual observer what could be described as a sloppy appearance. His hair was unkempt, his shirt-tail often out. He had begun his high school career by being involved in several mishaps which led to disciplinary action. Some of his teachers regarded him as rather difficult to deal with. At the same time the boy exhibited a rather friendly attitude, and on occasion showed a genuine desire to please, coupled with many likeable qualities. Past clinical experience has indicated to the profession that a

* All names are fictitious.

sloppy appearance is often symptomatic of a conflict centered around the problems of growing up. An examination of Leonard's diagnostic test (score forty) tends to verify such a diagnosis. Consider the items checked off:

a. Misunderstands nature of decimal point in problems like $7.1+3.15+16$.
b. Does not use decimal rule correctly in division.
c. Mixes up $7\sqrt{56}$, $7\sqrt{63}$, $6\sqrt{54}$.
d. Fails to reduce fractions.
e. Changes denominator incorrectly.
f. Copies answer incorrectly.
g. Does not invert divisor in dividing fractions.
h. We note, in addition, that the student clerk wrote the following comment on Leonard's paper: "What a mess!"

Discussion with Leonard revealed that, of the above items, only the first two were due to misunderstanding of the process involved. Other errors showed on his paper which could not be held to any definite pattern, and could be explained only on the basis of sloppiness. Leonard is left-handed, a partial explanation of the slanted columns of numbers on his papers. We helped him devise a method of using a 3×5 white card to help him keep his numbers in line. After two days, he discarded this crutch, and wrote passably neat work without it. After seven days, he took the test again and scored eighty one points out of eighty seven. We wish to note that during the period of instruction, he asked the following question: "Mr. Bernstein, do you come in extra early to give us kids this special help?" Since we sensed what was on his mind, we lied and answered his question in the affirmative. "Well," he said, "if you can do that for us, I guess we ought to put out for you."

It would be an illusion to believe that this boy learned much arithmetic in the seven days which he spent in the Mathematics Clinic. It seems more accurate to believe that be was aided in resolving some of his hostilities toward the adult world. He was also aided in reappraising himself, since he genuinely believed that he was very deficient in arithmetic. His subsequent behavior in class and in school generally, indicated that in the struggle for maturity, maturity was winning out. This, too, is teaching.

c. *Emotional Insecurity or Other Emotional Problems, Not Necessarily Influencing the Method of Instruction. To illustrate this situation, let us consider the case of Jean G.:*

This girl had had a very unstable home situation for three years previous to her enrollment at Cody High School. Her parents had been divorced and she had been moved around from one situation to another, attending several different schools over a period of three years. The semester she enrolled at Cody High School was the first stable period in her life subsequent to the divorce. She was living with an aunt, who apparently showed genuine interest in the child. Her counselor reported to the instructor that Jean was extremely insecure, and had great fears about her ability. However, she was very anxious to succeed and her insecurity presented no obstacle to her teachers in either a classroom or a clinical situation.

The procedure, therefore, was to analyze her weaknesses and faults in arithmetic and deal with these without discussing personal problems with her. The relationship was primarily instructional, and assumed therapeutic aspects only in that the situation served to build confidence and self-respect. It is unnecessary to list her arithmetic deficiencies in great detail to illustrate this principle.

It should be noted that Jean scored thirty points out of eighty-seven on the

Diagnostic Test in September, 1953, and scored sixty-one on another form at the end of the semester in January, 1954. This improvement was achieved without clinical instruction, during the classroom phase of the study. (Described earlier in this article.) Examination of the second test revealed that deficiencies still existed and clinical instruction was begun at this point. It is worth noting, that unlike the previous cases described, Jean also had deficiencies in her basic tables of subtraction, multiplication, and division.

The technique used was similar to that described by Fernald. The Detroit Public School Test on the basic facts was given to Jean and the time of completion noted. The papers were examined for patterns of wrong answers. For example, Jean made nineteen errors or omissions in the multiplication table. Analysis revealed that ten of these errors involved multiplying by zero. ($2 \times 0 = 2$, etc.) Further analysis revealed that the other errors were paired, i.e., 7×8 and 8×7, or fitted into the table of products of nine. This kind of analysis was conducted with Jean watching so that she could be convinced that she had but six facts to master instead of nineteen in order to gain control over the table. A related step in instruction was to show Jean that the facts she had wrong on the division table were generally the same ones, i.e., $7\overline{)56}$, etc. This process of narrowing down the area of study was a boost to the girl's morale, a factor noted in many cases where the problem of mastery of the tables was involved.

(It had been the writer's experience, verified by other workers in this field, that the bulk of deficiencies in multiplication and division were in the tables of 7, 8, and 9, particularly when multiplied by high numbers. Deficiencies in the subtraction tables generally involved subtraction from numbers higher than 12.)

Two programs were used to help Jean with the problem. One was the use of flash cards, with a student assistant giving her the drill. The other was a method of writing out the successive facts in the tables of 7, 8, and 9. Jean was also taught to speed up subtraction by the process of bridging tens. She showed very rapid improvement on the tables and was able to show reasonable mastery of them two weeks after this instruction was begun. Seven weeks after she entered clinical instruction, Jean was retested on the Diagnostic Test and showed a score of seventy-four points, losing only two points on what could be described as errors of misunderstanding. The remaining errors on her paper could be classified as random.

The emotional factors which helped in the situation were the excellent relationships which existed not only between Jean and her instructor, but also between Jean and her counselor. Her over-all adjustment to the school was excellent. She further bolstered her self-confidence by becoming a leading competitor on the girls' swimming team. The gains in arithmetic achievement must certainly be given some credit for her over-all improvement. Follow up information revealed that Jean had moved to another city, and had achieved a grade of B in tenth grade commercial arithmetic.

d. *Low Achievement as a Product of the Test Situation Rather than a Lack of Knowledge:* Numerous students have reported to the writer that they become nervous in test situations. However, some who do are still able to perform satisfactorily on the test. The clinical instructor must learn to be sensitive to those cases which have mastery of the subject matter in question, but are unable to display this

mastery under the pressure of a test situation. Consider the case of Jack S.:

Jack's examination, as of January, 1954, showed a score of fifty-seven points. A diagnosis revealed only two items of misunderstanding:

1. He tended to omit zero as a placeholder in long division.
2. He misunderstood the decimal rule in division.

One wonders why Jack should have such a score with only two misunderstandings. His test paper revealed several items where points were lost by omissions, or by such carelessness as copying his own handwriting incorrectly. Subsequent work with Jack revealed that, although he was slow spoken and slow moving, he could do accurate work in a daily class work situation when not rushed. However, if not pressured somewhat, he would dally and take too long to finish the work. In addition to the two items above, he was found to have weaknesses in the multiplication and division tables. After practice, he showed improvement on these, but when retested, still took 4 or $4\frac{1}{2}$ minutes to complete them. Since he could respond to flash cards automatically and correctly, we concluded that the poor time was a product of the test situation. When Jack took the arithmetic test after ten weeks of work, he scored sixty-eight. This time his paper revealed no patterns and we concluded that the errors were random in character. A loss of nineteen points due to random errors is considerable and we encouraged Jack to practice a little further and try the test again. He later scored sixty-six points on another form, with a pattern of random errors similar to the previous test. Jack's inability to respond to the pressures of the examination must be deduced as the principle limiting factor in his achievement.

Many students have come to the author's attention who are greatly limited in school achievement for this reason alone. Indeed, some students will be classified as remedial problems, who are not remedial at all. This factor is also a major source of error in educational studies, particularly when test results are correlated. Some students will testify that they become nervous only on mathematics tests. A smaller number will testify that they become nervous in all test situations. Jack was the latter type. The former type can often obtain help from clinical instruction. The prognosis for the latter is poor. We believe this is a major unsolved problem in education.

In general, the patterns described in these four cases were repeated in many cases, although the specific diagnostic items varied from case to case. The teaching techniques described are adequate for the majority of cases. Space does not permit description of rare patterns experienced by the author, some of which are mentioned below:

a. Student cannot bridge the gap from concrete to abstract understandings.
b. Student is over-meticulous and fails to finish a test.
c. Student exhibits extreme hostility toward subject.
d. A subconscious emotional attitude led to deliberate failure.
e. Student exhibited a block on a specific item.
f. Student gained in arithmetic, but showed no gain in social adjustment.

(Interested readers will find these cases described in detail in the author's Ed.D. dissertation, under the same title as this article, available at the Wayne University library.)

Fifty-nine cases were closed in the second semester of the clinical study, and ten were partially completed. The closed cases had a mean gain of 19.1 points on the Diagnostic Arithmetic Test (power score) with individual gains ranging from one to fifty-three points. Forty-six of these cases had a mean gain of 23.3 points on the same test, in speed scores. The closed cases had a mean number of 6.0 diagnostic items before instruction and 1.1 items after instruction. All of these figures are very significant. The mean power score of the retest was 73.1, comparable to the mean for the previous year's Algebra students' of 73.8. The classroom grade distribution of forty-three students discharged from the Mathematics Clinic eight weeks before the end of the semester reveals only eight failures, six of which were attributed to personality problems.

Individualized instruction, dealing with all types of student deficiencies, was much more effective than instruction of large classes with corrective exercises, and in much less time. This was particularly noticeable in those aspects of behavior which can be roughly classified under morale. Gains in self-confidence, and increased liking for mathematics were evident in both situations, but much more so in the Mathematics Clinic.

Considering that the large majority of the cases taught in the Mathematics Clinic were dealt with at the symptomatic level, it appears that a teacher does not have to be highly trained in clinical psychology to do this kind of work. The essential requirements are some competence in the teaching of arithmetic, sufficient human understanding to be able to infer nervousness, hurrying, "freezing," or other natural, emotional responses from a student's work, and the ability to interpret these inferences to the student in everyday language. A teacher entering a clinical situation without the traditional prejudices commonly expressed regarding "slow-learning" students will find a most gratifying, indeed a most exciting experience.

WORKSHOP FOR MATHEMATICS TEACHERS AT INDIANA UNIVERSITY

The Ninth Annual Workshop for Teachers of Mathematics will be held at Indiana University June 18 through June 30. The general theme this year will be, "Teaching Mathematics for the Next Generation." Dr. H. Vernon Price, of Iowa City, will be one of our leading speakers and consultants. We will also have speakers on other phases of science, industry and business. An opportunity will be offered for members of the workshop to work on problems of their own choosing, as well as to work in the materials laboratory.

Graduate credit of $2\frac{1}{2}$ semester hours is available for those who desire it. A complete program will be available in May.

For further information write to Philip Peak, School of Education, Indiana University, Bloomington, Indiana.

ELMER E. BURNS

1868–1956

In February of this year the Association lost one of its most venerable members. Elmer E. Burns joined the CASMT in its second year, 1902, and attended nearly every annual meeting until the last one in Detroit in 1955. He was born February 22, 1868 in Iowa, where he received his elementary and high school education and graduated from Simpson College, Indianola, Iowa. Here he began his teaching career. He received the master's degree from the University of Chicago in 1899, then taught in DeKalb, Illinois high school for five years. His next place was at the Medill High School in Chicago with his home at Berwyn in 1904. Many years later, when the changing population in Chicago brought a decrease in enrollment at Medill he changed to the Austin High School, where he continued teaching physics until his retirement in 1935.

But retirement from teaching did not mean any decrease in his work. He was then engaged in putting out a new textbook in physics. His first textbook, *The Electric Motor and Its Practical Operation*, came out early in his career as a teacher in Chicago. This was soon followed by *The Story of Great Inventions*. With Joseph G. Branch he next produced *Practical Mathematics for the Engineer and Electrician*. In 1912 his *Alternating Currents Simplified* appeared. This book was a new model in the field of electricity explaining, what was then considered a subject for college students, to boys of high school age. His reputation as an author was now made. In 1917 his *A Practical Physics Manual*, with co-authors W. R. Ahrens of Englewood High School (Chicago) and T. L. Harley of Hyde Park High School (Chicago) appeared and found ready adoption in many Chicago high schools and elsewhere over the nation. *Radio, a Study in First Principles* and *Electricity, A Study in First Principles* followed in rapid succession. Finally in 1943 his greatest book appeared, *Physics, a Basic Science*, co-authored by Herbert C. Hazel and Frank L. Verwiebe, a book which with constant revision and improvement has been a leader in high school classes throughout the country for thirteen years. His entire professional life was spent as a great teacher and an excellent writer of high school textbooks.

Mr. Burns was one of the first members of the CASMT to whom emeritus membership was granted. He was married to Harriet Tompson on June 23, 1898. His death occurred at Berwyn, February 13, 1956, just a few days before his eighty-eighth birthday. But his death does not mean that the teaching world has suffered an irredeemable loss, because his influence as a good neighbor to all his friends in Berwyn and throughout the nation, a great teacher of all

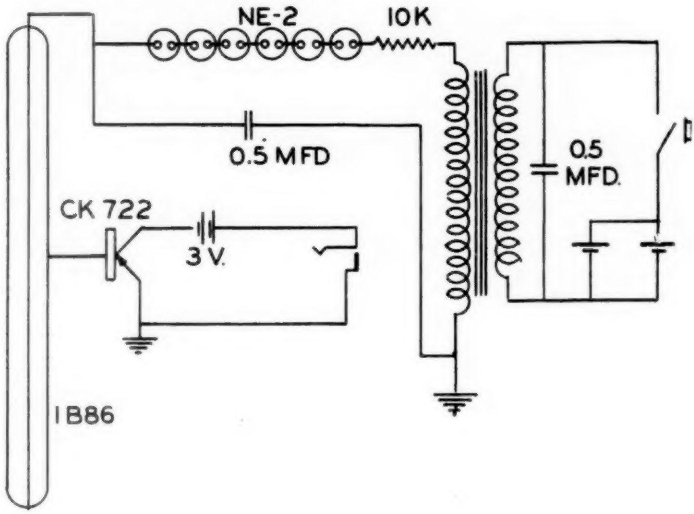
the countless number of his physics students, and a textbook writer without peer, continues with us.

MILTON D. OESTREICHER
RAY C. SOLIDAY
GLEN W. WARNER

A SIMPLE GEIGER COUNTER PROJECT

GEORGE EDGAR BRADLEY
Western Michigan College, Kalamazoo, Mich.

The appearance on the market of low voltage Geiger tubes such as the Victoreen 1B86 provides the means for a simple project in the construction of a portable Geiger survey meter. The instrument employs a 1B86 Geiger tube, a CK722 transistor or equivalent, a one ampere 6.3 volt filament transformer and six NE-2 neon bulbs. The instrument may be powered by two or four penlight dry cells.

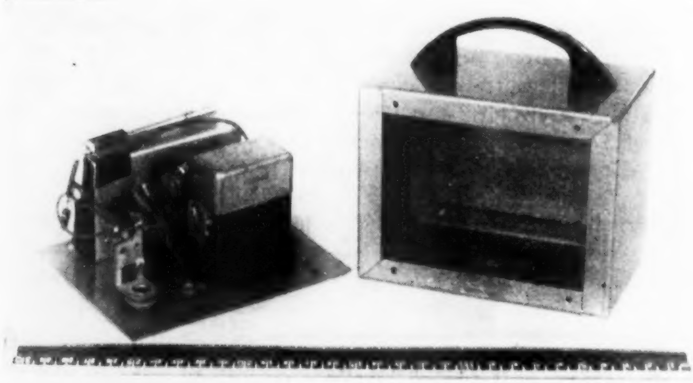


Since the transistor is used to amplify the Geiger pulse, crystal phones are not needed, but quite audible "clicks" may be heard with ordinary 2000 ohm headphones. The transistor used in this way constitutes the conventional grounded emitter amplifier.

The 300 volts for the Geiger tube is supplied by interrupting by means of a push button switch the current in the primary of the transformer. Actually the filament transformer is used in reverse with the

6.3 volt winding acting as the primary. Upon the breaking of the circuit, the six neon tubes conduct,—charging a capacitor. Overcharge is not possible since the neon tubes act as regulators as well as rectifiers. Preliminary polarity tests will indicate proper connections of the transformer for charging the capacitor positive with respect to ground. Several interruptions will charge the capacitor sufficiently for several minutes operation.

Figure I shows a diagram of the counter and Figure II a photograph of the author's model built on a 3″×4″×5″ chassis with a cupboard door handle for carrying.



Although simple in construction and made from standard parts available from any large radio store for less than $12.00, this piece makes a serviceable unit. The experience of construction makes it an ideal project for senior high school physics.

DEPARTMENT OF BIOLOGICAL SCIENCES

The Department of Science at Margaret Morrison Carnegie College has been renamed the Department of Biological Sciences, and part of the science instruction given by the Department has been transferred to the Carnegie Tech College of Engineering and Science, President J. C. Warner announced.

Instruction in the biological sciences will continue at the women's college, but chemistry, mathematics and physics courses will be transferred to the appropriate departments in the College of Engineering and Science beginning July 1, 1956.

Dr. Warner explained that the advantages in the move are two-fold: "Margaret Morrison faculty members concerned will become members of a large science department where daily association with colleagues in the same field will provide greater stimulation and exchange of ideas." The second advantage is administrative. "Instruction and the degree in each of these three sciences can now be offered by one college instead of two."

Women students seeking a degree in chemistry, mathematics, or physics will be enrolled as regular students in the College of Engineering and Science.

THE CONSTRUCTION OF SPECIAL SLIDE RULES AND NOMOGRAPHS FOR THE TEACHER OF GENERAL CHEMISTRY

II. NOMOGRAPHS

LYMAN J. WOOD

Department of Chemistry, St. Louis University, St. Louis, Missouri

INTRODUCTION

The word nomograph is derived from the Greek word ***Nomos***, meaning a law and a nomograph may be considered to be the expression of "law in graphical form." While the nomograph may be in general a graphic representation of numerical relations by any one of a

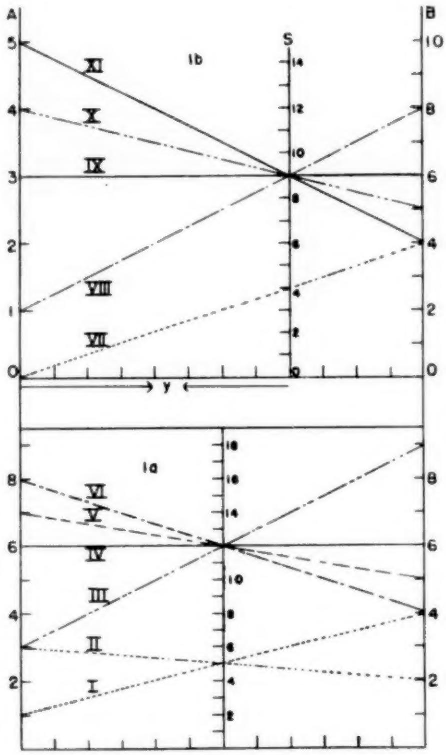


FIG. 1. A nomograph based on the simple equation $A+B=S$. In Fig. 1a one unit on scale B is equal to one unit on scale A and two units on scale S. Scale S is at the mid-position. In Fig. 1b one unit on scale B is equal to $\frac{1}{2}$ unit on scale A and $1\frac{1}{2}$ units on scale S. Scale S occupies a position at $\frac{1}{3}$ of the distance from scale B to scale A.

number of various systems, it has become more and more common in recent years (especially the last 25 years) to think of nomographs as alignment diagrams. An alignment chart is a graph that makes it possible to read off the value of a dependent variable when the value of the independent variable is given. This is done by laying a straightedge across the chart.

The index line defined by the straightedge cuts three scales as shown in Figure 1 and the numbers indicated by the three intersections satisfy the underlying equation, which, in this case, is an exceedingly simple one, viz., $A+B=S$. For any given index line the sum of A and B is read on the S scale. If only a limited portion of scale A is to be used such as zero to 5 for example, one unit of the A scale may be made equal to 2 units of the B scale as shown in Figure 1b and accuracy in reading can be gained. However it will be necessary to relocate scale S and recalculate the value of one unit on the S scale. Considering index scale IX it is to be seen that 6 units on the B scale are equal to 9 units on the S scale and that one unit on the S scale is therefore 6/9 or 2/3 of a unit on the B scale. On index scale VII, in which case A is equal to zero, the reading on the S scale must be equal to the reading on the B scale and the height on the S scale must be 2/3 of the height on the B scale. It follows then that y (the distance of the S scale from the A scale) must be 2/3 of the distance from the A scale to the B scale (8 divisions out of 12). When the S scale is so located intersections of any index line will satisfy the fundamental equation, e.g., index lines VIII, X and XI satisfy the equation $A+B=9$ in each case.

For such a simple relation as $A+B=S$ it would be easier to add A and B than to prepare a nomograph. Figure 1 has been drawn only for the purpose of explaining the underlying principles but it is just as simple to use a nomograph based on a more complicated equation. Any difficulty encountered will be in the preparation of the nomograph,[1] not in its use. Indeed one of the important advantages of the nomograph is, that once it is prepared, it can be used rapidly and accurately by individuals without special training.

In Figure 2a the fundamental equation is $5/3\ A+B/2=S$. If the ranges of A and B are sufficiently limited and if frequent day after day use of this equation is required, the preparation of a nomograph for graphical solutions of S might be practical and advantageous. In Figure 2 let one unit on the A scale be equal to two centimeters and one unit on the B scale be equal to one centimeter. For index line II, A is equal to 3 and B is equal to 6 from which $5/3 \times 3 + 6/2 = S = 8$ and one unit on S is 6/8 or 3/4 of a centimeter. The location of the S

[1] "Empirical Equations and Nomography," Davis. McGraw-Hill (1943).

scale is calculated as before by drawing an index line to zero on scale A (line I). The height on the S scale is $3/4 \times 3$ which is 3/8 of 6 from which it follows that y is equal to 3/8 of 12 which is 4 1/2. In Figure 2b the equation is $5/3\ A+B/2+2\ 1/2=S$. One unit on the S scale is still 3/4 of a centimeter and this scale is still located 4 1/2 centimeters distant from the A scale but it must be moved down 2 1/2 units.

In Figures 1 and 2 only additions are performed but it will be recalled from paper I[2] on slide rules that multiplication and division

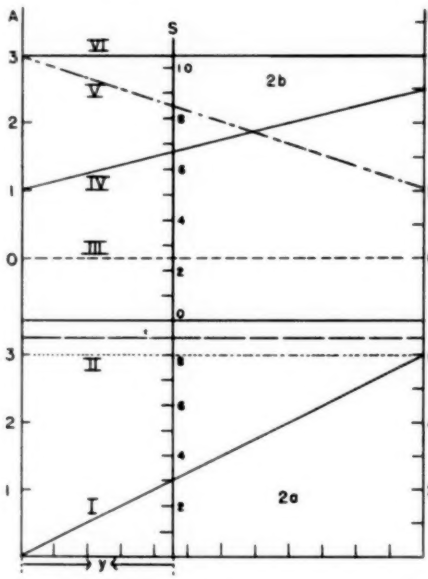


FIG. 2. In Fig. 2a the fundamental equation is $5/3\ A+B/2=S$ and in Fig. 2b it is $5/3\ A+B/2+2\ 1/2=S$. In each case the unit on scale S is 3/4 of a unit on scale B and in each case scale S is at 3/8 of the distance from scale A to scale B. In Fig. 2b it is necessary to lower the S scale 2 1/2 units because of the additive factor in the equation.

can be performed by adding or subtracting logarithms (Figure 3). Let scales 1a, 1b and 3 represent logarithm scales 25 centimeters long. Scale 2, at the mid-position, consists of two logarithm scales, each of which is 12.5 centimeters long. This arrangement of scales[3] can be printed in the inside cover of a book and hence be available for ready reference. However, because of the reduction in the length of the number 2 scales, it is not as accurate as a 25 centimeter slide rule. On the other hand, if the readings on scale 1a are to have a limited

[2] This *Journal*, May, 1956, p. 381.
[3] The "String Calculator," Wood. Copyright by Lyman J. Wood, 1949.

range (e.g., if readings on scale 1a will always be between 3 and 4) and if the readings on scale 3 are to have a limited range (e.g., 4 to 5), then all of the scales can be greatly expanded and accuracy can be gained. Even such limitations would scarcely justify the labor involved in drawing a nomograph if the equation is as simple as $N_1 \times N_2 = P$. If however, an equation something like $(5/3\ A)(B/2+1) = P$ is to be used repeatedly day after day and if the values of A and B are to be limited to narrow ranges, the construction of a nomograph may be found to offer great advantage.

A very large number (1700) of nomograms have been indexed by D. P. Adams[4] and a number of text and reference books covering the

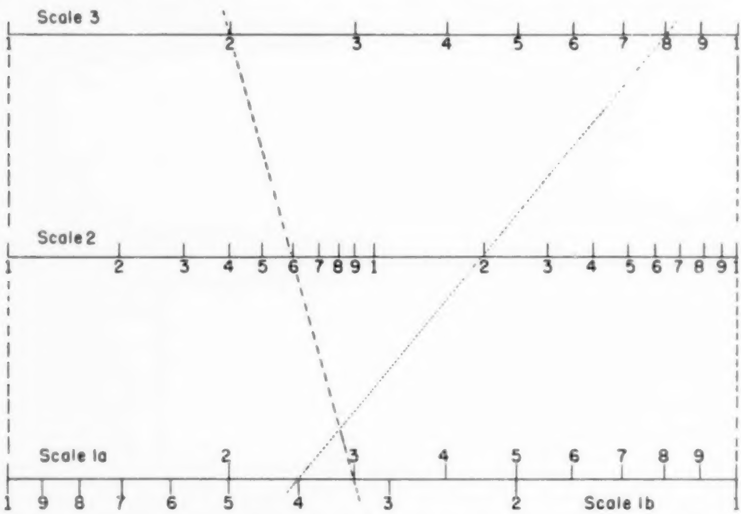


Fig. 3. To multiply 3 in scale 1a by 2 in scale 3, connect the two numbers by means of a string and read the product on scale 2. To divide 8 in scale 3 by 4 in scale 1b, connect these two numbers by means of a string and read the quotient on scale 2.

general subject of nomography are listed in a bibliography in the book by Davis.[1] Four readily available references,[5–8] selected from the index by Adams, are listed for the convenience of the reader. Two nomographs that have been constructed and used in the author's laboratory are described in the section that follows.

[4] "An Index of Nomograms," D. P. Adams. Published jointly by the Technology Press of Massachusetts Institute of Technology and John Wiley and Sons (1950).

[5] "Approximate Solutions to Problems Involving the Ideal Gas Law," Calandra, *J. Chem. Ed.*, 17, 15 (1940).

[6] "Nomograph for Connecting Barometer Readings for Temperature," Troxel, *J. Chem. Ed.*, 17, 431 (1940).

[7] "A Nomograph for the Estimation of the Activation Energies of Unimolecular Reactions," Warrick, *J. Chem Ed.*, 20, 134 (1943).

[8] "A Nomograph for Acetate Buffers," Boyd, *J. Am. Chem. Soc.*, 67, 1035 (1945).

Two Special Nomographs

Figures 4a, 5a and 5b are photographs of combination nomographs used for two quantitative experiments in general chemistry. One of these is the determination of the atomic weight of sulfur which was described in paper I on special slide rules. Except for incidental reference, this experiment will not be discussed further. The other experiment involves a determination of the formula of potassium chlorate, $KClO_3$—specifically the number of atoms of oxygen in the formula, which for purposes of this experiment, becomes $KClO_X$.[9] In both nomographs the value of X is the final answer sought; the dependent variable which is calculated from the laboratory data and which in the end is to be compared with the accepted value of three from the formula $KClO_3$.

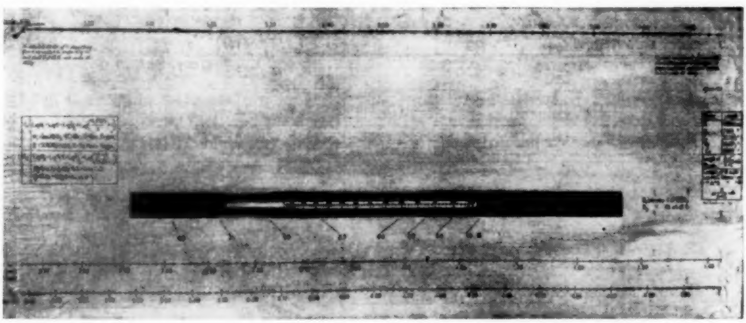


Fig. 4a. (See also Fig. 4b). Scales A, B_1 and C_1 are used for calculating X of KClO (the number of atoms of oxygen in the formula for potassium chlorate) and the scales are related by the equation $\log M - \log O = \log (1/P) + \log [(4.6595/X)+1]$. Scales A, B_2 and C_2 are used for calculating the atomic weight of sulfur and the scales are related by the equation $\log M - \log \mathrm{FeS} = \log (1/P) + \log [55.85/(55.85+S)]$—see paper I. The nomograph is mounted on a board 3/4 of an inch thick with end cleats to prevent warping. Scales B_1 and B_2 are placed on the front and back faces of the tongue of a slide rule which is reversible.

[9] The unknown for this quantitative determination consists of potassium chlorate and a small per cent of inert material (potassium chloride) which varies from unknown to unknown. The per cent of potassium chlorate in the unknown is related to the student's serial number (paper I), a record of which is kept by the instructor. The student is instructed[10] to weigh between 5 and 6 grams of unknown into a previously ignited and weighed test tube containing about 0.25 grams of manganese dioxide. After thorough mixing, the test tube and contents are heated to drive off oxygen. After cooling and weighing, the student has the weight of oxygen driven out of his unknown. If now he knew the grams of potassium chlorate contained in the amount of unknown weighed into the test tube, he could calculate the number of atoms of oxygen in the formula of potassium chlorate (X of $KClO_X$). However, at this point, the student knows only the grams of oxygen lost and the grams of mixture taken (not the grams of potassium chlorate in the mixture).

These two data are now reported to the laboratory attendant who calculates first the needed grams of potassium chlorate, which he gives to the student and second the value of X which he retains for future comparison with the student's final report. Both of these quantities can be calculated by the use of the nomograph shown in Figure 5 but only X can be calculated by the use of the nomograph shown in Figure 4. When this latter nomograph is used, the grams of potassium chlorate is calculated by means of a series of fixed ratio scales related to the student's serial number N, similar to the fixed ratio scales described in paper I. As a matter of fact, Figure 4 of paper I contains fixed ratio scales above each row of serial numbers for calculating this very item.

[10] "Experimental Chemistry for Beginners," Wood. Copyright by Lyman J. Wood, 1947.

It is assumed that potassium chlorate decomposes completely according to the equation 2 $KClO_3 \rightarrow 2\ KCl + 3\ O_2$ from which the funda-

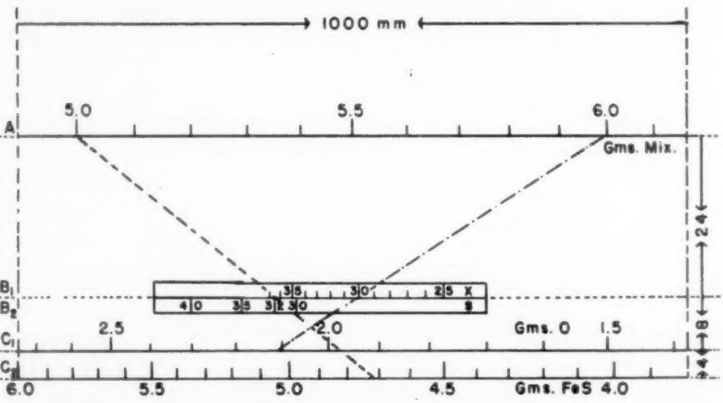


FIG. 4b. This drawing shows some details that may not be clear in Fig. 4a. The B_1 scale is set for an unknown mixture that is 90 per cent potassium chlorate. The B_2 scale is set for an unknown mixture that is 60 per cent iron.

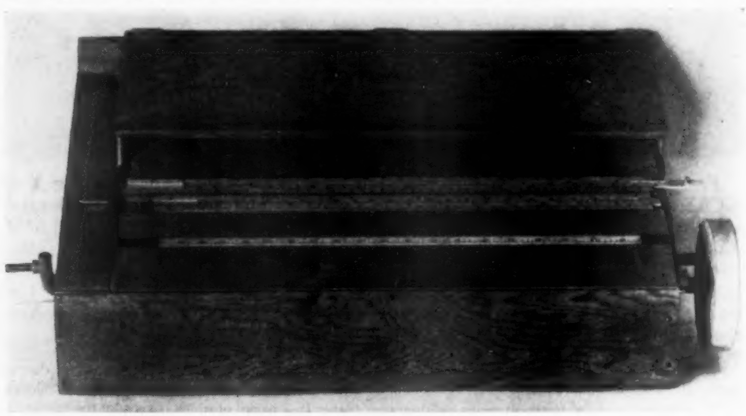


FIG. 5a. (See also Figs. 5b, 5c and 5d.) When the scales of this nomograph are properly set (they are not set in this photograph—see Fig. 5d) the thread stretches from point P (upper right hand corner out of sight) across the scales to some given point on scale 1 (the bottom scale showing under the slit). Copies of scale 1 mounted on the cylinder (Fig. 5b) are shifted from unknown to unknown as demanded by the changing composition. The cylinder is rotated by means of the handle on the left until the appropriate setting of scale 1 is in view under the slit. Scale 2 (the second scale from the bottom) is movable but must be adjusted and locked into position for any given series of unknowns. Scale 3 (the one extending to the right with the thumb catch) must be movable since it carries the experimentally determined grams of oxygen which must be moved under the thread in order to read the value of X (the number of atoms of oxygen in the formula of potassium chlorate).

mental mathematical relation is

$$\frac{PM}{O}=\frac{39.1+35.46+16X}{16X} \tag{1}$$

where P is the per cent over 100 of potassium chlorate in the unknown,[9] M is the grams of unknown taken and O is the grams of oxygen lost. The scales of the nomographs are related by the equation

$$\log M-\log O=\log (1/P)+\log \left(\frac{4.6595}{X}+1\right) \tag{2}$$

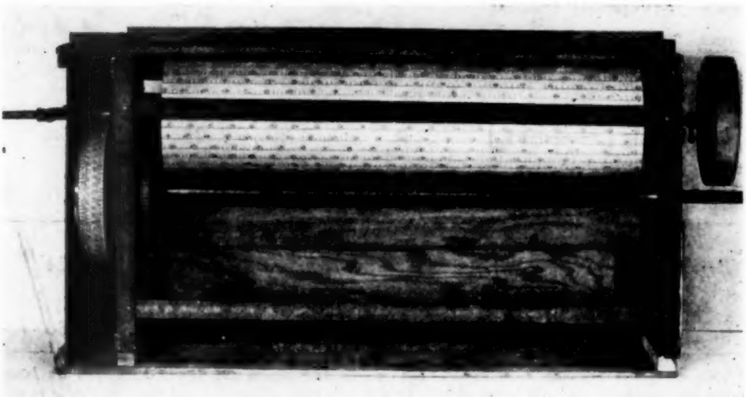


FIG. 5b. This photograph shows a bottom view of the calculator shown in Fig. 5a. The number wheel at the left contains the serial numbers assigned to the individual members of the class. For each serial number there is a tooth on the cogwheel and for each tooth there is a scale which occupies a lateral position along the cylinder consistent with the composition of the unknown that it represents. When the student has finished his laboratory work and is ready to make a preliminary report of his experimental data, he turns the number wheel until his serial number appears under the hair line (Fig. 5a) at which time the proper scale for calculating his data automatically comes into place under the slit. The wheel at the right is for the convenience of the operator and permits him to make a final, fine adjustment of the scale position before stretching the thread into position.

In the nomograph shown in Figure 4, log M is plotted on scale A, log O is plotted on scale C_1 and log $(1/P)$+log $[(4.6595/X)+1]$ is plotted on scale B_1 which must be movable to that it can be set for different values of P ($P=90/100$ in Figures 4a and 4b). The distance between two of the three scales (A, B_1 and C_1) can be arbitrarily fixed on the basis of convenience and the moduli (Table I) of the two selected scales may have any desired values but the modulus and position of the third scale (scale B_1 in this case) must be calculated. This can be done as described above for Figures 1 and 2. With the

moduli for scale A and scale C_1 in the ratio of three to one we have

$$\left(\frac{3\times 1}{3+1}\right)\left(\frac{100}{3}\right)=25 \text{ millimeters for the modulus of scale } B_1 \text{ and}$$

$$\left(\frac{3}{3+1}\right)32 \quad =24 \text{ millimeters for the distance between scale } A \text{ and scale } B_1.$$[11]

TABLE I. THE SCALE RELATIONS FOR FIGURE 4

Scale	Quantity Plotted	Label	Modulus* in mm.	Distance from Scale A in cm.
A	$\log M$	Gms. of mix.	100	—
B_1	$\log\left(\frac{4.6595}{X}+1\right)$	X	25	24
C_1	$\log O$	Gms. of O	33 1/3	32
B_2	$\log\left(\frac{55.85}{55.85+S}\right)$	S(at. wt.)	33 1/3	24
C_2	log FeS	Gms. FeS	50	36

* The modulus is the change in millimeters when the logarithm changes 0.01. The modulus is made as large as possible considering the total length of scale (in this case 1000 millimeters) and the total change in the logarithm along the scale.

TABLE II. THE SCALE RELATIONS FOR FIGURE 5

Scale	Quantity Plotted	Label	Modulus* in mm.	Perpendicular Distance from Point P in cm.
1	$[\log P+\log M]$	Gms. of mix.	40	36
2	log gms. $KClO_3$	Gms. of $KClO_3$	31	27.9
3	$\log O$	Gms. of O	27	24.3
4	$\log\left(\frac{4.6595}{X}+1\right)$	X	27	Immediately above Scale 3

* The modulus is the change in millimeters when the logarithm changes 0.01.

[11] Because scale B_2 is on the back of the tongue of the slide rule, its location is fixed by the position of scale B_1. For scales A, B_2, and C_2, it is the modulus and position of scale C_2 that must be calculated. Scale B_2 has been drawn as shown in Figure 4b for the purpose of illustration but it would be somewhat difficult to place both scale B_1 and B_2 on the front face of the moving tongue of the slide rule.

Scale B_1 in Figure 4b is set for a mixture that is 90 per cent potassium chlorate. If 6 grams of this mixture be taken (which contains 5.4 grams of potassium chlorate), $5.4 \times 48/122.56$ or 2.11 grams of oxygen should be lost upon heating. An index line drawn from 6.0 in scale A to 2.11 in scale C_1 cuts the B_1 or X scale at 3.0 which is the accepted number of atoms of oxygen in the formula for potassium chlorate.[12] An experimental error in weighing the unknown mixture or in the determination of the grams of oxygen lost will cause the

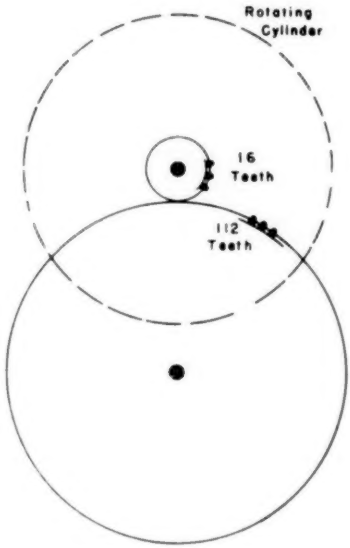


FIG. 5c. Showing end view of the cylinder and cogwheels. The cylinder has a diameter of 16 centimeters and is 64 centimeters long. The small cogwheel has 16 teeth and the large cogwheel 112 teeth. The crank then rotates the cylinder seven times for each complete revolution of the number wheel.

calculated value of X to deviate from 3.0.[13] After all of the experimental values of the grams of mixture taken and the corresponding values of the grams of oxygen lost have been tabulated, the instructor can, by the use of the nomograph shown in Figure 4, quickly check the accuracy of the X values calculated by each member of his

[12] In a similar manner, scales B_2 and C_2 can be used for calculating the atomic weight of sulfur. An index line drawn from 5 in scale A (in this case 5 grams of a mixture of iron and sulfur containing 60 per cent iron) to 4.72 grams of iron sulfide in scale C_2, cuts scale B_2 at 32, the atomic weight of sulfur.

[13] This deviation will at once indicate to the student something of the accuracy of his work. Furthermore the procedure followed eliminates, rather effectively, the possibility of dishonest modification of the laboratory data in order to obtain a better value of X. This is so because the laboratory weighings have been reported before the student can begin to calculate X. Both of these circumstances are important psychological factors.

class, even when the class is very large (of the order of several hundred!).

The fundamental equation for the nomograph shown in Figure 5 is obtained by rearranging equation 2 as shown in equation 3

$$[\log P+\log M]-\log O=\log\left(\frac{4.6595}{X}+1\right) \tag{3}$$

in which $[\log P+\log M]$ is equal to the logarithm of the grams of potassium chlorate (this is so because the product of P and M is equal to the grams of potassium chlorate). In constructing the nomograph, $[\log P+\log M]$ is plotted on scale 1, logarithm of the grams of potassium chlorate on scale 2, $\log O$ on scale 3 and $\log[(4.6595/X)+1]$ on scale 4. Because P changes from unknown to unknown, scale 1 must

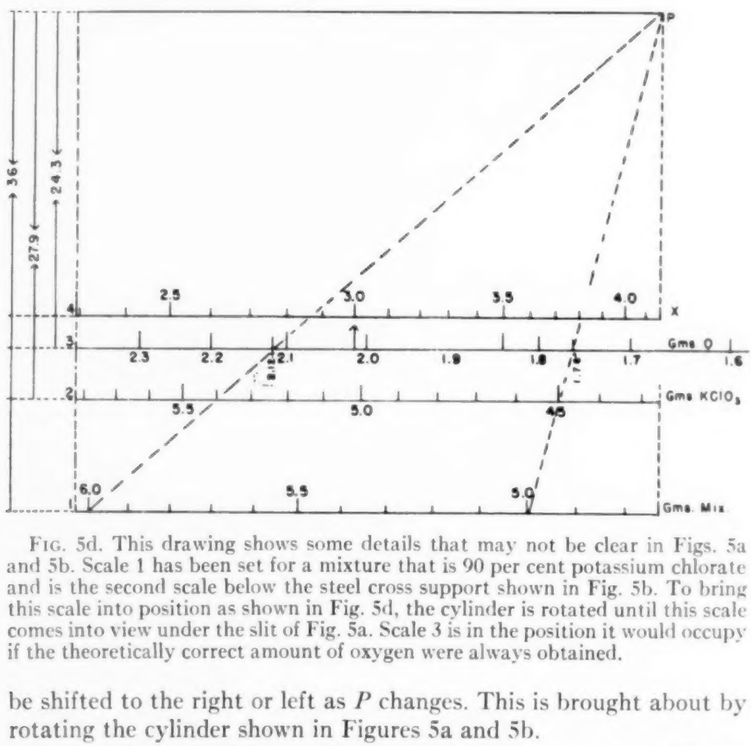


FIG. 5d. This drawing shows some details that may not be clear in Figs. 5a and 5b. Scale 1 has been set for a mixture that is 90 per cent potassium chlorate and is the second scale below the steel cross support shown in Fig. 5b. To bring this scale into position as shown in Fig. 5d, the cylinder is rotated until this scale comes into view under the slit of Fig. 5a. Scale 3 is in the position it would occupy if the theoretically correct amount of oxygen were always obtained.

be shifted to the right or left as P changes. This is brought about by rotating the cylinder shown in Figures 5a and 5b.

A thread stretched from point P to any point on scale 1 (Figure 5d) will cut across scale 2 and give at once the grams of potassium chlorate in any given amount of mixture, e.g., if the thread is drawn from P across 5 grams of mixture on scale 1, 4.5 grams of potassium

chlorate is indicated on scale 2. The grams of oxygen that should be produced by heating 4.5 grams of potassium chlorate is readily calculated to be $4.5 \times 48/122.56 = 1.76$. With the thread still stretched from point *P* to 5 on scale 1, let 1.76 on scale 3 be moved along until it is directly under the thread. In this position the arrow on scale 3 will be directly under 3.0 on scale 4 (the *X* scale).[14] An experimental error in weighing the grams of unknown mixture or in the determination of the grams of oxygen lost, will cause the arrow to indicate some value of *X* other than 3.0—the value of *X* produced by the laboratory data.[13]

The scales of Figure 5 represent an interesting combination of the principles of the nomograph and the slide rule. When the thread is drawn from point *P* across scales 1, 2 and 3, three similar right triangles are formed and it is found that the moduli of these three scales (Table II) are proportional to the altitudes of these three triangles, i.e., the distances of these scales from point *P*. Scale 1 was plotted 36 centimeters away from point *P* and the moduli for scales 1, 2 and 3 were made respectively 40, 31 and 27 millimeters for a logarithmic difference of 0.01. Scale 2 must then be plotted $31/40 \times 36 = 27.9$ centimeters away from point *P* and scale 3 must be plotted $27/40 \times 36 = 24.3$ centimeters away from point *P*. However, the modulus for scale 4 is the same as for scale 3. This is so because the two scales are compared directly with each other in accordance with the principles of the slide rule.[15]

The most important advance made in the construction of the apparatus described in Figure 5 is the rotating cylinder by means of which, together with the related number wheel, the student makes the correct setting of scale 1 required for his particular unknown. Figure 4 has the important advantage of simpler construction but suffers the disadvantage that it calculates only the final answer *X* and supplementary scales must be used for calculating the grams of potassium chlorate from the unknown mixture. The apparatus of Figure 5, though more difficult to construct, enables the instructor (with the cooperation of the student), with one stretch of the thread to read off the grams of potassium chlorate and with an additional setting of scale 3 to read off *X*. This calculator has been used successfully for rapid and accurate calculations for large numbers of students work-

[14] The location of scale 4, with 3.0 approximately in the mid-position, is based on convenience. With the thread stretching across theoretical positions on scales 1 and 3, the arrow is drawn on scale 3 directly under 3.0 on scale 4. Once the location of the arrow on scale 3 and the position of scale 4 have been fixed, they must thereafter remain unchanged. It is interesting to note that the existence of scale 2 is not necessary for calculating *X*. It is very convenient however, because it is no longer necessary to use separate scales for calculating grams of potassium chlorate as was necessary when using the nomograph shown in Figure 4.

[15] The moduli of all four of these scales could be made the same if a draftsman's triangle were moved along a guide at the base for making comparisons. It is believed that this would be neither as convenient nor as rapid and perhaps not as accurate as the use of the thread as described above

ing simultaneously in the laboratory and it is believed that it could be readily adapted to even larger groups if necessary.

Papers I and II of this series are dedicated to the cause of serious scientific effort in beginning laboratory work—to the instructors who are sufficiently devoted to meet exacting teaching demands and to the students who are willing to submit to the discipline required by rigorous intellectual endeavor in the laboratory. The interested reader will no doubt be able to amplify and extend the ideas discussed in these papers and adapt them to his own special purposes.

HARVARD SUMMER SCHOOL

A special course on "Recent Developments in Physical Science," with a correlated course on "The Teaching of Science," will again be offered for secondary-school science teachers by the Harvard Summer School and Graduate School of Education. Twenty duPont fellowships of $400 are available for these courses, which will last from July 2 to August 15 and will each carry four units of graduate-level credit. The courses are open to any interested and qualified teachers, whether or not they receive one of the fellowships.

In addition to these courses for secondary-school teachers, there will be a course on "Science in the Elementary School" for teachers and supervisors on the elementary level.

"Recent Developments in Physical Science" will be taught by Philippe E. LeCorbeiller, Professor of Applied Physics, Harvard University. This course will deal with the relation between recent scientific advances and the logical or historical backgrounds from which they arose. It will stress the interrelations not only between sciences, but also between contemporary developments in several fields of science and in technology. The topics of the lectures will be drawn largely from two main areas and will be fitted to the students' interests and preparation: (a) atomic and nuclear physics and chemistry, nuclear reactors, use of radioactive isotopes in biology and industry; (b) electronics, automatic control, digital computing machines, applications to industry and business. In order that the treatment of recent developments may be more than superficial, special emphasis will be placed on fundamental information and concepts. There will be lecture demonstrations, as well as frequent visits to research laboratories.

The course on "The Teaching of Science," to be taught by Associate Professor Fletcher G. Watson of the Harvard Graduate Sohool of Education, will explore the ways in which recent scientific developments can be used in the classroom. Objectives, techniques, and materials for teaching basic scientific concepts will be considered in detail. Insofar as practicable, the concepts and developments will be those involved in the course on "Recent Developments."

The course on "Science in the Elementary School" will include a summary of the interests and abilities of elementary-school children, a review of scientific topics from that point of view, an examination of texts, an examination of resources in a school community, and a workshop in the creation of usable equipment. The course will be taught by Mr. Ellis Spear. Instructor in Science, Eliot Pearson School, Tufts University, and Lesley Dearborn School, Lesley College.

The courses can be counted for credit toward the Ed.M. or the A.M. in Teaching by those who are admitted to one of these degree programs in the Harvard Graduate School of Education.

Also of interest to teachers will be a number of other courses in the sciences including astronomy, biology, chemistry, physics, and mathematics.

Teachers interested in applying for one of the fellowships may obtain an application blank from the Harvard Summer School, 2-N Weld Hall, Cambridge 38, Massachusetts.

ANIMALS IN THE CLASSROOM

JAMES EDGAR HYER
Culp Creek School, Culp Creek, Oregon

Having small animals in the classroom creates interest in science. Finding and keeping turtles, salamanders, snakes, or other similar animals results in good learning experiences. Teachers as well as students become interested as they observe and read books for information.

TURTLES

Except for large Snapping Turtles, turtles are not dangerous. If none can be found roaming about, small pet shop turtles will do. Turtles found locally cause students to make wider use of references involving desirable study habits, but pet-shop turtles will do very well if the brief instructions obtained with the turtles are not used as the only source of information.

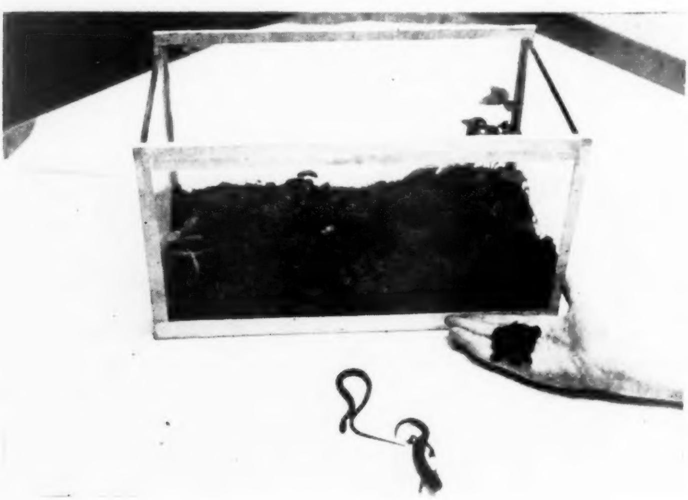
Local turtles are not always available when desired, but if the teacher discusses the desirability of having a turtle as a pet, at least one usually appears. Cold weather or hot dry weather causes turtles to burrow or seek shelter. They are more likely to be found during moderate or warm damp weather. As a last resort, a teacher can obtain pet shop turtles which are juveniles captured or incubated from eggs found in the wild. They deserve the same care as other turtles, and seem to adjust to confinement more readily than specimens brought in by the children.

For a classroom home, a wooden box with about three square feet of space and eight inches deep is adequate for one to four juveniles. The home should have a glass top to prevent escape. Deeper boxes confine the turtles well, but they make observation difficult unless sides are made of glass. Several small holes should be drilled in the ends for ventilation, about two inches of soil should be spread across the bottom, and a large dish or pan partially buried in the soil should be included so the turtles can swim. A ramp to assist the turtles in crawling out of the water is important. It should be made of material that will give them good footing. The ramp should be secured to the water container so that it will not be knocked aside; a poor ramp often results in a drowned turtle. The swimming pool adds to the fun of observation, and a small amount of plant life adds to the attractivenes of the box. Adult turtles require a similar but larger home.

Turtles should be able to bask in the sunshine as they wish, but they may die if they cannot find shelter when they have had enough. Moderate to warm room temperatures are good, although they survive well in higher and lower temperatures. If sunshine is not regu-

larly available, cod-liver oil should be added to a regular diet of chopped liver or beef, small fish, or earthworms with some fresh tender vegetables. Some adult turtles will not eat readily, but live minnows in a roomy swimming pool or live earthworms may entice them to eat. Some turtles can not eat unless they are able to take their food under water.

Captured adult turtles are more difficult to keep because they require larger and more secure homes. They usually try to escape and seem discontented for a few weeks, but they eventually make good pets and can be removed from their home by the children. Turtle races, with turtles starting from the center of a large circle, become a popular sport for some children. Adult turtles that have been marked when released at the end of the school year have been recovered in later years.



Salamanders and other Amphibians

All salamanders are harmless animals, even though some people dislike their looks or clammy feel. They usually spend their adult lives in very damp places on land.

In very damp, cool, heavily shaded areas of solid rock where old road beds have deep cuts, they can be found under heavy moss or in the cracks of the rock. A crowbar or some other tool may be needed to pry the rock apart. Some salamanders live under rotting leaves or rotten logs along streams. They usually feed on small slow moving animals such as snails, earthworms, centipedes, and insects, al-

though they will sometimes eat small pieces of chopped liver in captivity.

Most any container will do as a home for salamanders if it can be kept damp, cool, and ventilated, but an empty aquarium or a glass box is ideal. They eat little and seldom, and if not fed often they can be observed feeding.

Frogs, toads and salamanders will share a classroom home since they require similar food and surroundings. Lively insects such as termites and ants seem to be the favorite food of toads and some frogs, but they will also eat small earthworms and centipedes. A classroom home should always provide some cover such as leaves or pieces of moss for the salamanders and small toads.

Newts, similar to and often referred to as salamanders, have different skin and lead a more varied life than salamanders. Their skin is rougher and sometimes dry while living on land. They usually spend their infancy in water, about two years on land, and return to water for mating and the remainder of their lives. A common newt, often seen by curious boys, is colored a bright reddish orange to yellow on its ventral surface and is brown on top. Salamanders and newts have similar feeding habits, but a home similar to that for turtles is more suitable for newts. It allows them to select either water or land as their home. Some newts common in certain areas of the United States are known as water dogs. They should not be confused with a large type of water dwelling salamander known as a Mud Puppy.

Lizards

With the exception of the Gila Monster of Southwestern United States, lizards of North America are not poisonous. They can be found along old railroad beds, rock piles and other dry areas where there is plenty of sunshine. Lizards are usually caught by hand, but not without difficulty. It is not uncommon to end up with a wiggling tail as the lizard scampers away.

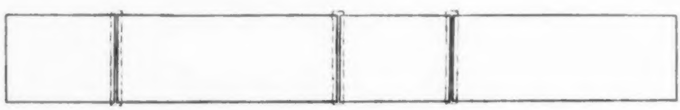
Like other cold blooded animals, lizards require little food. They seem to do well on worms and live insects such as ants and termites. Small tender plants grown from seed in a jar lid which is watered regularly will provide the necessary water and vegetation that some lizards require. They usually drink dew and some lizards need tender green vegetation for food or medicine. A dry, well ventilated home with plenty of sunshine is also necessary.

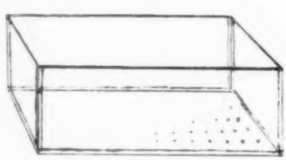
A glass box or an aquarium with a lid will do nicely as a classroom home if dry and ventilated. The contents should resemble the habitat of the lizard and provide cover for smaller lizards if larger lizards are kept in the same container.

Snakes

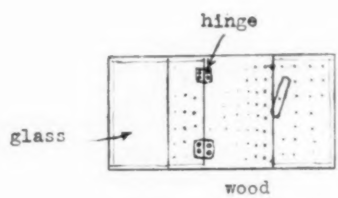
Garter Snakes and some other harmless snakes are easy to manage and make interesting pets for children. A glass box or an old aquarium will serve as a home if the container is large enough. Snakes should be able to move about freely so the home should be at least as long as the longest snake. Large adult snakes can pry a lid aside and escape, so it is wise to weight the lid or fasten securely especially if a crack around the lid is used for ventilation. All snakes are adept at escaping, and most women teachers dislike finding snakes in their overshoes.

Adhesive tape is placed under the glass while glass is flat, leaving a space the width of the glass.





Glass is folded into box shape, last corner is taped, and the glass is placed over a wooden bottom.



A lid with ventilation holes.

Small frogs and toads, small fish and small salamanders are good food for snakes. Small snakes may prefer earthworms and juicy insects or larvae. Healthy snakes can go great lengths of time without eating and seldom eat in captivity until well oriented. Attempts to feed them too soon may be disappointing, but after a few weeks a hungry snake will usually eat a small frog if the snake is not disturbed otherwise. As a snake swallows a frog, observers may watch the snake's lower jaw drop down as it disengages. Previous discussion about the eating habits of snakes should include an explanation of this peculiar ability.

Snakes don't drink with their mouths. They absorb moisture other than what they eat from their surroundings as do many other small animals. A long heavy container that they can crawl through should

be used for water. Adult snakes thrash around in their homes when prying and attempting to escape, so lightweight water containers are seldom satisfactory. Plant life is also difficult to keep in an adult snake's home.

A snake's mouth can be easily pried open after a bit of practice. By holding the snake behind the head, force a pencil point or a sharpened stick into its mouth near the front and pry as the sides of the head are squeezed. As the mouth opens, push the stick across the rear of the mouth with both ends of the stick or pencil sticking out each side.

Courtesy Eggen Photo, Lebanon, Oregon

K'Jilene Hagen and her friends are often found searching under rocks and boards for food acceptable to her pets. Enthusiasm for such good learning activity is shared by children of many ages.

This will keep the mouth open for observation. The lower jaw will not drop down. Many teeth are broken and some may stick into the demonstrator's fingers, but they seem to be harmless and can be removed like small briars. Broken teeth will be in the pencil or stick, but the snake will grow new ones. The tongue can be observed in its tube and its purpose explained. The slant of the teeth can be observed or felt of with the fingers of the children. Due to excitement and slight injury, the snake may not readily eat for some time, but the demonstration involves student learning and motivates the study of snakes.

The study of snakes should emphasize the differences in harmless

and poisonous snakes, as well as show how some snakes benefit man by destroying garden pests and rodents. A study of poisonous snakes may be of value to the children in some sections of the country. They should be able to recognize the few poisonous snakes and the techniques of first aid for snake bite.

The Glass Box

The glass box, a satisfactory home for many animals, allows good observation. The contents should resemble the natural surroundings of the animal when possible. The box may be made of inexpensive glass cut to size when purchased. The sides and ends are taped together with adhesive tape while the glass is lying flat, allowing room for corners as the box is folded into shape. The bottom or the lid may vary according to taste or necessity. It is better to have an adult snake's home or a lizard's home made with a wooden bottom which has been drilled for ventilation. The bottom of the glass box should also be taped in place.

A small glass box for one salamander, frog, or small snake can be made to fit inside an inexpensive shallow pan filled with plaster of paris, which makes a bottom for the home as it hardens. A crack around a glass lid can provide ventilation. The pan and plaster of paris make the glass box a sturdy home that can be handled more safely by small youngsters, but pans for larger boxes are difficult to obtain. Wooden bottoms are often more practical.

Large glass jars, with perforated lids and laid horizontally with sticks taped to the sides to prevent rolling, make good temporary quarters, but they are very poor permanent homes. Variations of the glass box are much better. A few minutes of planning and work when making a glass box is justified by the increased ease of care, the increased chance of animal survival, and the greater ease of observation.

CARNEGIE TECH'S STUDENT RADIO STATION RENOVATED

WRCT, Carnegie Tech's student radio station, has completed a thorough renovation of its studios in the Carnegie Union this week.

The work included the installation of a new air-conditioned studio, a redesigned master control room, and a false ceiling covering 300 square feet of studio space.

Next year will mark the sixth anniversary of the progressive young station, which is a member of the Intercollegiate Broadcasting System, a network of many such stations across the country.

Located at 600 kilocycles on the AM dial, WRCT uses a "carrier current" method of broadcasting. With this system, the electric power lines in the Tech dormitories and buildings are utilized as the antenna for the station, enabling it to send signals directly into the student's radio sets without radiating illegally to the surrounding area.

Plans are under way now to add an FM outlet that will cover the Oakland district of Pittsburgh.

CONSTRUCTION OF A TEACHING AID FOR "NINE POINTS CIRCLE"

SHRI. M. R. LOKRE.
Ganesh Chauk. Harda. (Madhya Pradesh)

The geometrical proposition on the "Nine Points Circle" is the toughest of all the theorems. Children usually find it difficult to grasp and understand the proposition with its proof. This is the general experience of almost every teacher. As far as I can imagine this is mostly due to lack of a proper teaching aid on the matter in question.

During the session 1952–1953 while I was under teacher's training at the Prantiya Shikshan Mahavidyalaya, Jabalpur, our learned professor of mathematics Shri. D. G. Kulkarni talked to us about Mathematical projects and insisted on the pupil teachers to undertake and complete some project of their own choice. Being inspired by the professor's insistence and also being obsessed by the question "Can I construct a teaching aid for the Nine Points Circle"? I pondered over it and ultimately took up the construction of the proposed teaching aid as my project. I devoted almost a fortnight in imagining and mental planning. Suddenly an Indian grinding wheel supplied me with the necessary idea. But the simple grinding wheel consists of a fixed base over which the grinding wheel rotates. I thought to myself "Can I make a thin circular collar ring rotate and pass through the Nine Points of the Triangle?" The question at first baffled me and I was almost hopeless about the project, when suddenly a little bit of mechanical knowledge suggested to me the actual construction. On the lines of the mechanical intuition, I worked strenuously and ultimately I succeeded in constructing a fairly descent model of the Teaching Aid. That wooden model of the teaching aid for the "Nine Points Circle" is placed in the teaching aid section of the Prantiya Shikshan Mahavidayalaya, Jabalpur.

In the following paragraphs I propose to describe the construction of the teaching aid for the Nine Points Circle and its special significance with a view to popularise its use in teaching of mathematics and encourage mass construction of the same on commercial lines.

THE THINGS REQUIRED FOR THE CONSTRUCTION OF THE AID

(1) A smooth wooden plank 18 inches long, 12 inches broad and $\frac{1}{2}$ inch thick.

(2) A cylindrical wooden block exactly 6.8 inches in diameter and about 4 to 6 inches long. This block would have to be turned into a one piece pulley rotar on the lathe machine as per specification given

in the following diagram. The one piece pulley rotar will have a central bore $\frac{1}{2}$ inch diameter so as to admit the axle over which it would rotate.

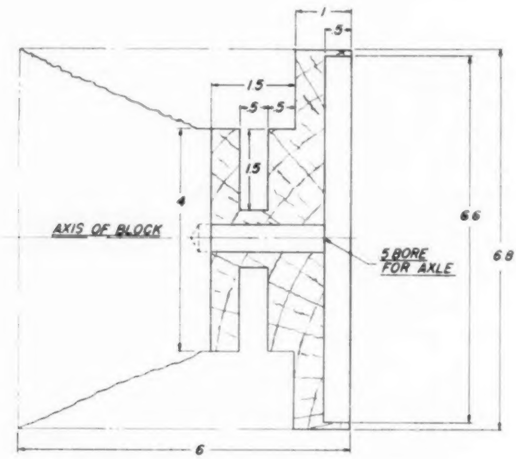


FIG. 1. Diagram of one piece pulley rotar.

(3) Iron axle (simple type) turned out on lathe machine with threads and nuts on both ends with specification given below in the diagram.

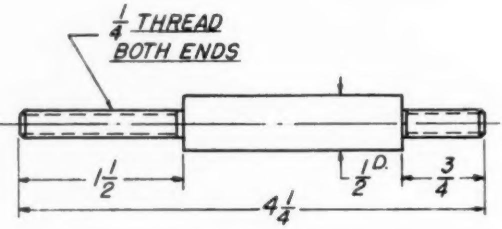


FIG. 2. Iron axle.

(4) A rectangular wooden bracket hub cut off from a tough wooden block 9 inches long, $3\frac{1}{4}$ inches broad and 1 inch thick. The specifications for the finished bracket are given in the following diagram.

(5) A wooden pulley with handle for rotating it by hand. The size of the pulley would be 5 inches in diameter and $\frac{3}{4}$ inch in thickness. The pulley would also have $\frac{1}{4}$ inch deep groove all round its circumferences to allow a string to be put over it. The pulley would also have a central bore of $\frac{1}{2}$ inch diameter.

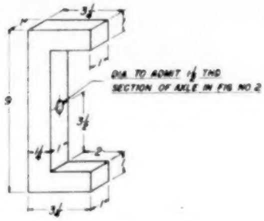


FIG. 3. Wooden bracket to hold axle.

(6) Another ordinary iron axle similar to that illustrated in No. 2 but differing in size, the specification being as given in the following diagram.

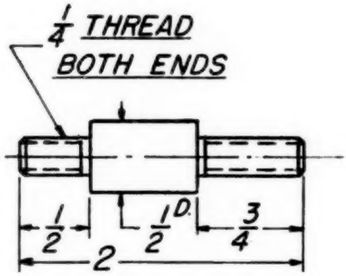


FIG. 4. A second iron axle.

(7) A stout string of requisite length to pass around the wooden pulley mentioned in No. 5 and the pulley of the rotar mentioned in No. 2 above.

(8) About 6 or 8 one inch long screws to fix the rectangular wooden bracket to the wooden plank from behind.

(9) Black and white paint for painting the wooden board and the figure.

Stage 1. Take a uniform smooth wooden plank $18'' \times 12'' \times \frac{1}{2}''$ in size. Draw a triangle ABC on it with base $BC=12''$, $AC=9''$ and $AB=13''$. Mark out all the Nine Points Viz: X, Y, Z, the respective mid points of these sides; D, E, F, the feet of the perpendiculars from vertices to opposite sides; and $a'b'c'$ the respective mid-points of straight lines joining the orthocentre to respective vertices. The whole figure would appear on the wooden plank as shown in Fig. 5.

Stage 2. Join Xa' on the wooden plank. Find its mid point N which is also the centre of the nine points circle. Now with N as centre and radii $6.8''$ and $6.6''$ draw two concentric circles to enclose a $.2''$ wide

circular ring on the plank (the actual radius of the nine point circle in the figure is roughly 6.7″. The two radia both differing one tenth inch from the actual radius are purposely taken to enclose the desired circular ring).

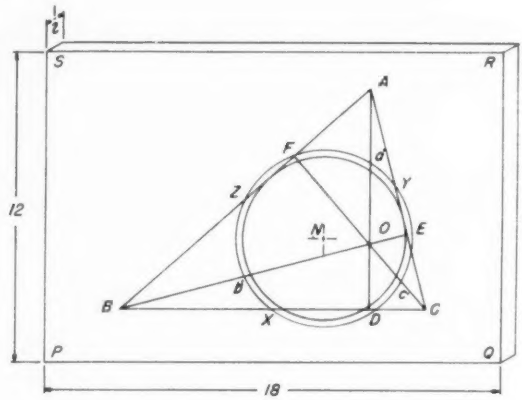


FIG. 5. The constructional stages and assemblage of the various parts.

Stage 3. Carefully carve out completely the .2″ wide circular ring by means of a sharp edged, roughly .2″ wide chisel which is fixed to a very stiff rounder and which is rotated round the point "*N*." The distance of the chisel from "*N*" is so adjusted that it moves along the circular ring. At every rotation chisel scrapes wood from the ring and the circular ditch goes on deepening. Finally the central disc 6.6″ in diameter and $\frac{1}{2}$″ thick is severed from the wooden plank leaving a round hole cavity 6.8″ in diameter in the plank.

Stage 4. Now take the 6.6″ diameter wooden disc just severed from the wooden plank and bore such a hole exactly at its centre to admit Iron axle No. 3 with its $\frac{3}{4}$″ threaded portion protruding out of the disc. A nut is put over the threads and the axle is tightly fixed to the wooden disc, centrally perpendicular to it.

Stage 5. Mount the wooden one piece pulley rotar on the axle fixed to the disc, so that the rotar collar smoothly rotates round the central disc.

Stage 6. Now bore a hole in the back side of the wooden bracket exactly at its mid point. Let other threaded end of the axle fixed to the disc protrude out of the bracket hole. Put a nut over the protruding threads and tighten it. This completes the most important part of the whole construction. Here it is to be noted that the axle should be centrally and perpendicularly fixed to both the bracket and the disc. Smooth rotation without jamming is only possible after

exact central and perpendicular fixation of the axle, then alone rotar collar would smoothly rotate round the disc as desired.

Stage 7. Now the bracket can be fixed to the wooden plank from behind the board by means of screws in such a way that central disc and the rotar collar round it exactly occupy the hole cavity created in the wooden board in stage 3 stated above. Since the axle is centrally fixed in respect of the cavity by means of the bracket, easy rotation of the rotar collar round the fixed central disc but within the board ring cavity is ensured.

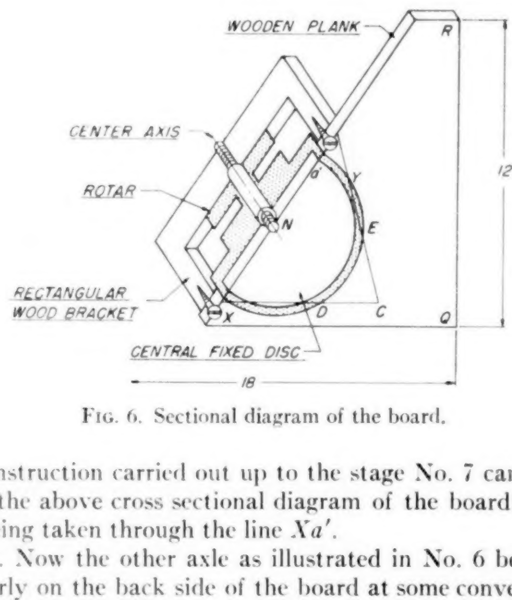


FIG. 6. Sectional diagram of the board.

The construction carried out up to the stage No. 7 can be understood by the above cross sectional diagram of the board. The cross section being taken through the line Xa'.

Stage 8. Now the other axle as illustrated in No. 6 be fixed perpendicularly on the back side of the board at some convenient place towards the side PS of the board. The wooden pulley 5″ diameter and with a handle can be mounted on the axle and a nut can be put on the threads of its axle. A string may now be made to pass round the groove of the 5″ diameter pulley and the central rotar pulley crosswise in the shape of the figure ∞. A brake arrangement can be fixed to the bracket for the rotar pulley, so that while stationary the rotar collar would be in its original position of rest.

Stage 9. Finally to complete the whole construction the brake is applied so that the rotar collar is in its original position of rest and the lines of the triangle, the perpendicular from the vertices to the opposite sides of the triangle and the points X, Y and Z on the rotar collar are painted by a little thick white paint. Thus all the Nine Points X, Y, Z, D, E, F, and a', b', c' get painted and distinctly

marked on the rotar collar. The names of these points are written by white paint on the stationary board or the central disc just immediately on the neighbouring space.

Remaining part of the entire wooden board is completely painted in tar black paint.

On completion of the constructional stages from 1 to 9 an efficient teaching aid for the tough geometrical proposition is obtained in respect of "Nine Point Circle."

How to use the Aid

(1) The aid be exhibited to the class of pupils using the brake so that the rotar collar may be in its original position of rest and they may see the figure 1 (without Diameter) on the board.

(2) By questions and answers the figure on the board can be *elicited* from the pupils. They will find no difficulty in grasping the figure and would automatically answer that ABC is the Triangle, X, Y, Z are the mid points of the sides of the triangle. D, E, F are the feet of the perpendicular from the vertices to the opposite sides and a', b', c' are the mid points of straight lines joining the orthocentre to respective vertices.

(3) The specific Nine Points being brought home to the pupils the class may now be asked to observe carefully and in the meantime while the class is attentively observing the teacher will put out the brake and rotate the wooden pulley by its handle. Suddenly the rotar collar begins to rotate speedily and thickly white painted "Nine Points" on it constitute a circle due to the principle of persistence of vision, the names of the points remaining stationary all the while.

(4) On sight of this every pupils eyes would glow with a visual concept of concyclic nature of the "Nine Points" of the Triangle and they would surely grasp the idea firmly.

Special Significance of the Teaching Aid of "Nine Points Circle"

(a) It provides a ready and easy grasp of the nine points of the triangle.

(b) On the collar being rotated by means of the wooden pulley the pupils suddenly and instantaneously without mistake catch up the visual concept of concyclic nature of the "Nine Points of the Triangle."

(c) The teaching aid affords an interesting illustration of the phenomenon of persistence of vision and in a way correlates mathematics with physics.

(d) Since the Aid itself is a mechanical contrivance it brings about correlation of mathematics with mechanics.

(e) It can be successfully used to explain the theoretical proof of the "Nine Points Circle" by using elastic bands. A lesson plan with the help of the teaching aid can conveniently be drawn out and the instruction can be made very easy and interesting to the pupils.

(f) It can also be used to illustrate and explain all the properties of the "Nine Points Circle" Viz.

1. The centre of the nine points circle lies midway between orthocentre and circumcentre of the triangle.
2. The radius of the nine points circle is half of the circum radius.
3. The centroid is collinear with circumcentre centre of the nine points circle and the orthocentre.

(g) It occupies an important place in the teaching of mathematics as much as the Newton's colour disc is important in teaching physics.

(h) The construction of the teaching aid as described above is not very difficult nor does it involve heavy cost or expenditure. The teachers can initiate their pupils under their guidance to construct one such aid successfully as a project and thus make them learn through projects.

(i) The construction as suggested above is capable of further improvement. A small electric motor can be attached to rotate the pulley rotar.

(j) The teaching aid is based on sound principles. Its idea is original in itself.

A NEW LOOK IN SCIENCE COURSES

The Catholic high schools of the Archdiocese of Boston will soon have a "new look" in their science courses. Revised courses of study for high school biology, chemistry, and physics have been prepared under the direction of Rt. Reverend Timothy F. O'Leary, Superintendent of Schools, and are to be released shortly.

These courses of study recognize the fact that in recent months leaders in education, science, and government have expressed concern about the present status of science teaching in the high schools of the United States. These spokesmen have pointed out that the elective system in high schools have made it possible for students to avoid science courses and acquire substitute credits in easier areas, and that the steadily declining enrollment in high school science courses has led to to their abandonment in a growing number of secondary schools. As a result, many high school graduates reach college completely lacking both knowledge and interest in scientific areas.

The seriousness of this situation for our nation is readily apparent when it is contrasted with information regarding secondary schools in the Soviet Union. In a recent address, Lewis L. Strauss, Chairman of the United States Atomic Energy Commission, said that forty per cent of the curriculum in Russian schools is devoted to science and mathematics. A longer school year makes it possible for a typical Russian high school graduate to complete the equivalent of six years of biology, five years of physics, four years of chemistry, and four years of mathematics.

THE USE OF SUBJECT MATTER PRINCIPLES AND GENERALIZATIONS IN TEACHING[1]

W. C. Van Deventer
Western Michigan College

I. Earlier Work on Principles and Generalizations

Any attempt to bring about uniformity in the teaching of science, either from the standpoint of what is taught or how it is taught, is probably undesirable or at least unattainable. Conditions and needs differ in different schools, groups of students differ, and instructors differ from the standpoint of what they can do best. All of these things must be taken into consideration in the planning of specific courses. In general, the more closely a course can be planned to meet local conditions and needs, and the more freedom that can be allowed in the development of it, the better the course.[2]

Nevertheless, there is real value in a constant re-examination of what we teach and how we teach it, in an attempt to reach out after larger ideas and generalizations, and to see the facts which our subject matter field contains in the light of these. This becomes particularly necessary at the present time when the mass of factual information which makes up the body of every scientific field has reached such an enormous bulk, and is constantly expanding at an ever-increasing rate. Perhaps some such overview may help to furnish a sound basis upon which to apply a "block-and-gap" technique[3] in the selection of subject matter for an elementary science course for non-specialists.

Studies of subject matter principles in biology have been carried out by Martin (1944) and Washton (1952).[4] Martin based his study on an analysis of textbooks, science in the news, and research studies on the principles of science. Washton integrated the results of earlier studies by Downing (1932), Winokur (1941), and Bergman (1944), as well as that of Martin. These other three studies were based on analyses of popular science publications, government publications and textbooks. Both Martin and Washton also utilized the opinions of experts, including science teachers and subject matter experts, to aid in validating their results.

The writer has been concerned for a number of years with the

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[1] Contribution No. 5, Department of Biology, Western Michigan College, Kalamazoo, Michigan.

[2] Van Deventer, W. C., "Designing a Basic Science Course for a Specific College Situation," School Science and Mathematics, February, 1955.

[3] Rogers, Eric M., "Science Courses in General Education," chapter in *Science in General Education*, Wm. C. Brown and Company, Dubuque, Iowa, 1948.

[4] Martin, Edgar W., "A Determination of the Principles of the Biological Sciences of Importance for General Education II." *Science Education*, Vol. 29, No. 3, April-May, 1945; and Washtow, Nathan S., "A Syllabus in Biology for General Education II. *Science Education*, Vol. 36, No. 4, October, 1952.

isolation and statement of generalizations of another type. These are the basic assumptions and ideas which make up scientific attitude. As such they are common to all science, and may be approached through the subject matter of any scientific discipline. although some of them were first recognized in connection with one particular scientific field, and seem more "at home" there than anywhere else. A list of these basic assumptions has been published in another connection, and their importance in the teaching of science in general education has been noted.[5]

II. A Hierarchy of Principles

It is apparent that a relationship must exist between subject matter principles of the type dealt with in the Martin and Washton studies, and the basic assumptions and ideas which constitute recognizable facets of scientific attitude. An additional relationship must exist in turn between principles of these two types and the facts of science. Furthermore the wide gap which exists between the basic ideas of an attitudinal nature and the factually-related subject matter principles may be taken to indicate the possibility of deriving generalizations which would lie at an intermediate level between these two. A careful examination of subject matter areas in biology reveals the possibility of statement of just such generalizations, each summarizing a particular area or broad topic. These are areal principles, bearing the same relation to subject matter principles that these in turn bear to the facts of science. Yet these areal principles are related in turn to the basic ideas which underlie all scientific disciplines.

There thus appears to be an easily definable heirarchy of generalizations and principles which can be set forth in relation to a particular subject matter field, and it is probable that, once defined, this hierarchy may be of value in teaching. (See Fig. 1).

The deep-lying assumptions and ideas include some facets of scientific attitude which define how a scientist behaves toward his world, others which define how he expects his world to behave, and still others which set forth the boundary posts of the kind of world which he thinks he has found. It is these latter facets which are particularly important from the standpoint of their relationship with the categories of progressively less broad generalizations which lie above them and which merge ultimately into the facts of science. There are at least four of these basic ideas which appear to apply to the world of science in general and to lie at the foundation of every subject matter discipline within it:

[5] Dressel, Paul L., and Mayhew, Lewis B., *General Education, Explorations in Evaluation*, "The Scientific Point of View," p. 112, The American Council on Education, Washington, D. C., 1954; and Van Deventer, W. C. "The Teaching of Basic Premises as an Approach to Science in General Education," *Science Education*, in press.

1. *Dynamism*: nature is dynamic rather than static, and exhibits constant variation and change.
2. *Relativeness*: the world and the phenomena in it consist of sets of relationships rather than absolutes.
3. *Intergradation*: nature is defined by continua, with related classes of natural phenomena grading imperceptibly into one another, rather than by sharp boundary lines.
4. *Practicality*: In any situation involving competition among units of varying potentialities, those which work best under existing circumstances tend to survive and be perpetuated.

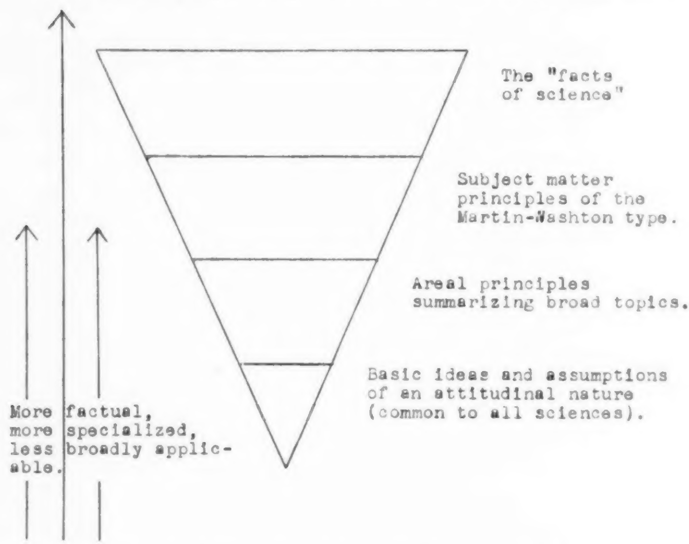

FIG. 1. A hierarchy of generalizations in science.

If these ideas are common to all science, they should be approachable through the medium of any subject matter discipline, and illustrations of them should be discoverable in any major scientific field. This is, in fact, true. Although historically a particular principle may show closer relationship to one particular scientific field than to others, as practicality does to biology and relativeness to physics, it is not difficult to demonstrate the broader application of these ideas. In the light of the scientific developments and thinking of the present time, the world which the scientist believes he has found is a dynamic world rather than a static one. It is a world of relationships rather than one of absolutes. It is an intergrading world in which there are no clearcut "blacks" and "whites," but rather shades of gray that merge and blend. Furthermore, it is a world in which that which

"works" survives at the expense of that which does not work or that which works less well.

The stratum of areal principles which lies above these all-prevading basic ones consists of ideas which serve to tie together wide segments of scientific knowledge, giving to these areas unity and meaning, both in terms of their own content and of their relationship with other areas. One such idea is that of community relationships within the groupings of plant and animal species that live in a particular habitat. This may be expressed in detail in terms of food chains, chemical cycles, niches and common reactions to environmental factors, or it may be expressed in overview by saying simply that single species cannot be completely understood when considered alone and outside their natural setting, and that any organism is most meaningful when it is considered as "part of a picture, which in turn is part of a larger picture, which is part of a still larger one, and so on out to the bounds of the universe, if, indeed, it has any bounds." This idea serves to give meaningful structure to the whole field of plant-animal relationships, and to much of the field of animal behvaior.

Another such unifying idea is that of the relationship of the Second Law of Thermodynamics or the principle of entropy to the field of biological conservation. Conservation has usually been phrased and taught in terms of "saving" or "preventing" or "preserving" or "controlling" or "increasing." As a branch of applied science it is of course concerned with purposes rather than merely with functions. Nevertheless it has suffered from the lack of unifying principles of areal nature. If we look upon biological conservation as being at least in large part "an attempt on the part of man to circumvent the loss through entropy of the solar energy which is fixed by green plants in the process of photosynthesis," we have one such unifying principle.

We cannot stop the loss of fixed energy through entropy which occurs at each step in the food chain. It is this which makes the food pyramid a pyramid of numbers, consisting of vast numbers of green plants, numerous herbivores and only a few carnivores. Conservation however, includes our efforts to circumvent this loss. Thus we may increase the numbers of herbivorous game animals by increasing the food (green plant) base through habitat management, and by eliminating the losses at the top of the pyramid through disease and carnivores. In doing these things we broaden the base of the pyramid and narrow its top. Similarly we may practice forest conservation by management of soil and water runoff, by encouraging the reproduction of desirable species and discouraging that of undesirable ones, and by destroying pests and diseases. We thus encourage the fixing of solar energy through photosynthesis in desirable forms, and prevent its destruction when once so fixed.

Perhaps a better example of this relationship of entropy is found in the matter of conservation as it applies to human food. Man was early able to increase his population by circumventing entropy through broadening his food base and destroying his carnivorous enemies. These things were accomplished by domesticating and propagating useful species of plants and animals, and coming to live in relatively large, cooperating groups. A further circumvention of entropy has taken place in every old civilization center, where in the evolution of food usage people have come to depend for food primarily on vegetable products (starch staples) rather than on meat. By thus largely eliminating one layer in the food pyramid as it applies to arable land, a larger human population can be supported. If ever we come to depend on yeast and algal cultures for food, or even on synthetic food, we will simply be circumventing entropy by further broadening the base of the food pyramid, possibly even to the extent of eliminating food as a minimal factor in the limitation of human population.

A third unifying idea of areal nature is that of the relative imperfection of the human body (or that of any other living organism) in relation to health and disease. We have inherited from our cultural ancestry the idea that the human body is a marvelously perfect creation, and the corollary idea that anything which attacks it or goes wrong with it is somehow evil. Modern medicine has, of course, long since abandoned this approach. but popular thinking, and even some teaching, has not done so. A logical development of the idea of evolution through natural selection and elimination of the least fit is that "the human body is not a perfect mechanism, but a relatively imperfect one, being only good enough to survive for long enough that the hereditary strains which it contains will not be lost to the race." The corollary to this idea is that medical science is concerned with discovering, developing and using a series of "crutches" to enable us to "limp across" the weak spots in our life cycles and survive a little longer. Even though these ideas may be a little shocking on first contact, they serve to tie together the whole field of health and disease and much of physiology, and to relate these areas to the area of evolution.

Similar unifying ideas can be found in other areas. To discover them it is only necessary to remove one's self from traditional approaches for long enough to "look at the forest instead of the trees." If this should result in a re-evaluation of teaching practices, perhaps that is not harmful.

The subject matter principles which form the third stratum are of a sort that is well-known. The recognition of generalizations of this type long preceded the formal listing of them by the writers mentioned

earlier. Most, if not all, statements of natural laws belong in this category. The following are examples of subject matter principles at this level listed by Martin and Washton.[6] They consist of summary statements describing the behavior of sets of phenomena or classes of things in the natural world:

1. The processes of a living body occur in the protoplasm; the sum total of these chemical and physical processes is called metabolism. (Washton).
2. In all organisms, increasing complexity of structure is accompanied by increasing division of labor. (Martin).
3. Throughout the life of every organism there is a building up and tearing down of protoplasm with constant transformations of energy. (Martin).
4. New types of living organisms may arise through mutation. (Washton).
5. In general, living things give evidence of a definite progression from simple to complex forms. (Martin).
6. Since hereditary factors of two parents combine at random during fertilization, the individuals of the following generations occur in certain predictable ratios. (Washton).
7. Every cell consists essentially of a mass of protoplasm, which is usually differentiated into a central portion, the nucleus, and an outer portion, the cytoplasm. (Martin).

The contents of the fourth stratum, which lies at the "surface," consist of the "facts of science," that is, the details which furnish support for the generalizations of the type just described. It is within this layer that the raw materials of scientific advance are accumulated, making possible new generalizations at the deeper levels, and increasing understanding of older ones.

III. Science Teaching in Relation to Principles

It is interesting and significant to examine science teaching and science textbooks in the light of this analysis. Few or no textbooks at the present time reach below the subject matter principle level. Many courses as they are actually taught do not reach below the level of surface facts. There are a few courses, mostly at the graduate level, taught by "inspired" teachers, which penetrate to the areal principle level. Very little teaching , and no textbooks, include the deep basic premises that underlie all science. Furthermore, no textbooks and no courses, as presently taught, present or recognize the natural hierarchy of principles and generalizations which is presented here.

The inclusion of this hierarchy of generalizations in a course, par

[6] *Op. cit.*

ticularly one designed for general students, and its use in teaching, however, presents the problem and the very real danger of overemphasis on the deductive aspects of science, and neglect of the inductive. A course based entirely, or even primarily on principles, however desirable it may be that the student understand science in these terms, would be a hopelessly one-sided course. The counterbalance to the heavy use of principles in teaching must come through the equally heavy use of laboratory. The laboratory, interpreted broadly as any type of problem-solving experience in connection with the natural world, whether by experimentation, observation or otherwise,[7] is historically the fountain head of science, the medium through which it was born, and the means by which it is still growing and advancing. Therefore it should lie at the heart of any science course, no matter how general or elementary the course may be.

It is possible to classify laboratory work under five general types:

1. *Illustrative.* Much laboratory work serves simply to illustrate facts already learned, in which the answer is or should be well-known to the student.
2. *Manipulative.* It is frequently emphasized that one value of laboratory work is to enable students to learn to handle apparatus and materials.
3. *Exploratory.* Many beginning courses, especially those of general education character, are providing laboratory problems whose answers are not definitely known, and whose exploration therefore involves true discovery.
4. *Experiential.* Most laboratory experiences do not involve controls, and therefore are experiential rather than experimental.
5. *Experimental.* Some laboratory work of a true experimental character, involving careful controls, should be a part of the program of every science student.

Although experiences of the first two types are by no means valueless, and certainly have a traditional place in science teaching, it is in experiences of the three latter types that the true laboratory aproach to science teaching principally lies.

We thus come to a concept of bipolarity in the planning and teaching of a science course. Ideas and generalizations, arranged in a natural hierarchy of decreasing breadth, and carefully related to the "facts" of science, constitute one pole, while laboratory work, especially that of an exploratory, experiential or experimental character, constitutes the other pole. In this way the deductive and inductive aspects in the course are balanced, as they necessarily are in the body of science itself and in all aquisition of new knowledge.

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[7] Van Deventer, W. C., "Laboratory Teaching in College Basic Science Courses," *Science Education*, Vol. 37, No. 3, April, 1953.

Experimentation is being carried on at Western Michigan College looking toward the establishment of a course of this type.[8] This is a one-semester course planned as a part of the college-wide general education program, but also fulfilling certain other types of functions within the biology department. It is a "block-and-gap" course based on a limited number of problem-areas selected from the field of biology. Of course it is necessary that the materials for such a course be written specifically for it. This project is also under way. At the subject matter principles level, Martin's and Washton's lists were taken as a starting point. They have been utilized as far as they correspond to the problem-areas which have been chosen, and they have been expanded as necessary to meet the further needs of these areas.

In each problem-area a single areal principle is set up as a point of integration. Each unit within a problem-area is built around either an areal principle or one or more subject matter principles of broad type. The less broad subject matter principles are utilized as summary statements at the ends of units. The deep-lying basic principles, common to all science, are included in a unit on the Nature of Science, which is so placed in the course that the student comes to it after having acquired some acquaintance with scientific materials. The surface facts of science are utilized throughout as tools for getting at concepts and for acquiring additional meaningful facts.

The whole presentation of principles is counterbalanced by a centering of each problem-area around laboratory experiences of an exploratory character.

IV. Summary

Work done by earlier writers in regard to the isolation and statement of principles in connection with the teaching of science has been largely at the level of subject matter principles, which are directly related to the details that constitute the facts of science. The writer, in an earlier paper, set forth also certain basic ideas or generalizations which appear to be common to all sciences.

If these deep-lying basic principles are considered in relation to subject matter principles it appears that there should exist other principles, intermediate in level, which serve to sum up wide areas of scientific knowledge. The isolation, statement and justification of some of these areal principles is a function of this paper.

It seems desirable that this natural hierarchy of principles be included in the teaching of science, especially for the general student, in order that there be developed a real understanding of what science is. This, however, should only be done within the framework of a kind of bipolarity, in which the deductive aspect of science, in the form

[8] *Op. cit.*

of this hierarchy of principles, is counter-balanced by an emphasis on laboratory, particularly of the exploratory-experiential-experimental type. Thus the inductive emphasis balances the deductive, as it does in the body of science itself. A science course for the general student, so built, may be thought of as the skeleton of the body of science on which facts, those taught in the course and those later acquired, constitute the flesh.

"CAREER OPPORTUNITIES IN BIOLOGY"—A NEW BOOKLET

The need for more biological scientists has prompted action by the National Research Council of the National Academy of Sciences. To interest young poeple in the life sciences, the Biology Council of that organization has prepared a booklet entitled "Career Opportunities in Biology." Row, Peterson and Company, textbook house and publisher in this non-profit enterprise, will send a copy of the booklet to every junior high school, high school, and college in the country during March.

Dr. Paul A. Weiss, head of the Laboratory of Developmental Biology, Rockefeller Institute for Medical Research, under whose chairmanship the booklet was prepared, tells students in the foreword, "This is the century of the life sciences—biology—which give man increasing control over his welfare."

The booklet states that at present a total of 64,000 people who are primarily biologists devote full-time to the subject. (This estimate is that of the Scientific Manpower Commission, published in 1955.) In the future, a continuing supply of new workers is needed to meet the growing demands in established branches of biology. Moreover, trained people will be needed for the new fields which will open.

Russell B. Stevens, executive secretary of the Biology Council and author of "Career Opportunities in Biology," says in the new booklet, "There is a place for the high school graduate, the college graduate, and the advanced scholar." He estimates that for every full-time research biologist, teacher, civil servant, or administrator, there is a need for three to five people as technicians, clerical workers, laboratory aides, student assistants, animal caretakers, etc. There is also a place in biology for mathematicians, agriculturalists, businessmen, artists, writers, librarians, and people with mechanical aptitudes and skills.

Some of the dramatic developments in biology during the past fifty years listed by Mr. Stevens in "Career Opportunities in Biology" are antibiotics, chemotherapy, radiation biology, conservation, and isotope research. In medicine and health, two of the many problems being studied by biologists are the secrets of virus multiplication and the relation between the chemical structure of sulfur compounds and their disease-preventing activities.

During the next fifty years, biology may offer ways of supplementing man's food supply with algae as more orthdox items are in short supply, Mr. Stevens tells students. Other new developments may include "securing minerals from seaweed on a major scale, directing the pathways of inheritance, farming the arctic and the tropics, capturing the energy of the sun in the laboratory, or investigating the biology of another planet by the year 2000."

Demonstration Kits for the classroom show water conservation methods and water pumps. Two available kits let the student build and operate a conservation project tray and water project pumps. The kits are complete with the necessary equipment and manuals of instruction.

SEASONS AND WEATHER

A UNIT FOR PRIMARY GRADES

Alphoretta Fish
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A science unit can provide the child with "doing" experiences which will help him successfully take his place as a participating member of society. *Is* the young child a "doing" or "participating" member of society? Definitely! He is concerned with getting along with people. Getting along with people necessitates "doing" or "interaction" such as sharing ideas, materials, goals, and outcomes. The young child is, or should be, responsible for doing his share of the world's work, small though his share may be. Developing effective work skills is essential; and a science unit can provide opportunity for "doing" such things as working together, assuming responsibility, deciding the problem, manipulating materials and equipment, experimenting, and evaluating. Then too, a child is responsible in relative and increasing measure for his own health and safety. The "doing" of looking for and observing relationships as well as the "doing" of being aware of "cause and effect" can be related by the child to concerns for his own health and saftey, as well as to the health and safety of others.

Units in themselves function only suggestively, and while a science unit is designed primarily to develop scientific attitude and to increase the child's understanding of the world in which he lives, the "total" child-growth which develops will depend upon the ingenuity of the teacher. Keeping in mind (1) the needs of her group, (2) the maturity level of the children, and (3) the resources available, the teacher can plan through the sequence of steps and "doing" activities or learning situations which will bring about the desired results.

Some Suggested Observations and Activities

The Seasons as a Whole Unit of Time:

Weather: Predicting weather is not a good activity for the beginning scientist since weather is not caused by local phenomena and cannot be predicted effectively by an analysis of weather conditions of a local area. The emphasis throughout this unit, therefore, is on the relationship of seasons and weather and the adaptation of living things to seasonal change.

1. Keep a weather chart for a month typical to each of the seasons.
2. Study the weather as it "comes up."
   a. On a rainy day, notice the clouds, the air. How does the air

feel before the storm? How does it smell after the storm?

b. If it hails, bring a hail stone into class and cut through it to show the layers of ice formed when the raindrop was bumped up and down from warm air to cold air.
c. Demonstrate with a prism how the falling raindrops bend the sun's rays to form the rainbow.
d. On a foggy morning, demonstrate how fog is formed.

3. Help the children become aware of the "cause and effect" relationships of weather. For example, a look at the sky before leaving for school helps the child determine what he should wear to school.
4. A reflective examination of the completed weather charts will help the children become aware of the time involved in a year. Also, the following might profitably be discussed: How does weather vary from season to season? Is all winter weather cold? are all the days of summer hot?

Health and Safety: A consideration of health and safety factors can result from the child's own careful observation of "cause-effect relationships. Help the child examine such topics as:

1. What time of the year do we have the most colds? Why? If one member of the family catches a cold, do the other members usually catch it? Why? What could we do to prevent colds? Are colds expensive?
2. What kinds of accidents occur most often in the fall and winter? In the spring and summer? Which kinds of accidents most frequently involve boys and girls? Why? How can we become better "safety citizens?"

Fall:

1. Observe a sumac over a period of time to see *how* the leaves gradually change color.
2. Examine a branch and notice
   a. How nature protects the branch by "healing over" the place where the leaf falls off.
   b. That the new buds are already formed for the next year.
   c. The amount of growth of the branch during the year.
3. Observe the preparations or "adaptations" being made for winter by
   a. Man
   b. Plants: Examine to see where food is stored.
   c. Animals
      (1) Watch for flocks of migrating birds. What does "migration" mean? Which animals migrate?

(2) Examine the fur on pets. What is happening?
(3) What are the ants doing? The squirrels? Others?

4. Make a collection of leaves and/or seeds. Identify and discuss.
5. Demonstrate "hibernation" by allowing a frog to go into hibernation in the refrigerator. What does "hibernation" mean? Which animals hibernate?

Winter:

1. Examine snowflakes with a hand lens. Catch them on a piece of black velvet which has been allowed to cool outside. Are they alike in any respect?
2. Identify animal tracks in the snow. How are they different? Similar?
3. Which plants are still green?
4. Which birds are still with us?
5. Build a bird-feeding station and feed the birds.
6. How does winter differ from fall?

Spring:

1. Look for "signs of spring." Listen for "signs of spring."
2. Visit a farm to see new baby animals.
3. Collect frogs' eggs from a stream and watch them hatch.
4. How does spring differ from winter? Is spring similar to fall in any way? How does it differ?

Summer:

1. Keep a bird chart. Record: Name of bird, date seen, by whom, and where seen.
2. Observe the local birds. Concentrate on a very few, two or three.
3. Observe the kinds of nests birds build and where they build them.
4. Observe the kinds of food birds eat and try to determine whether birds are helpful or harmful.
5. In what ways are birds alike? How do they differ?

Books for the Science Table

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Spring Is Here	*Plants Round The Year*

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A CITRUS OSCILLATOR

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This time I decided to do something about it. Having just shown the class the usual effect when strips of zinc and copper are thrust into a lemon, I was immediately asked what good the little cell could do. After all, it was so small.

A little work that night produced the following circuit, which, when assembled, proved to be a rather convincing demonstration. The circuit is designed around a Raytheon CK-722 junction transistor, now available for less than a dollar. The rest of the components are standard, except perhaps for the phones. High impedance phones are required, such as Brush No. 202A, a crystal phone. The lemon cell goes where shown, the copper, of course being the positive electrode. The entire apparatus was assembled on a small sheet of plastic, about 3×5 inches, using Fahnestock spring clip connectors secured through the plastic with 6-32 machine screws.

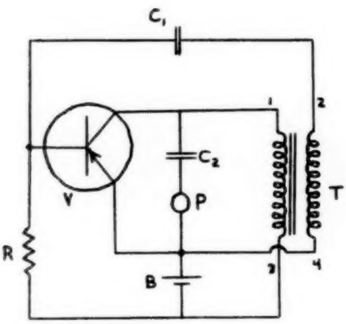
The oscillator produced an extremely loud tone that could be heard all over the room. I left it connected all during the day, just to show the students what a lemon could do. Taking a moment in physics class to explain that a transistor could operate off of a very few milliwatts and therefore portended miniaturization of electronic equipment, one of the students pointed out that a lemon is hardly considered miniature. It was true that the lemon was larger than all the rest of the oscillator, except for the phones. What to do?

As has happened so often in the past, science leaped forward on a flash of genius. The next day, the students found that the lemon

oscillator had been miniaturized by converting it into the world's first kumquat operated oscillator. Much to our surprise, it continued to oscillate loudly for seven days, until I got tired of listening to the shriek and took it down.

The frequency of oscillation can be varied by varying the value of the resistor, and, as a matter of fact, by bringing a hand near the ear phone.

All this, of course, suggests basic research. I wonder what would happen with a grapefruit?



V = Raytheon Junction Transistor CK-722
R = 220K ohms, ½ watt
C_1 and C_2 = 0.01 mfd., disk type
P = crystal phone, Brush No. 202A
B = kumquat cell with zinc and copper electrodes, observing polarity
T = UTC SSO-3 transistor transformer
1 = blue
2 = black
3 = red
4 = black

QUESTIONS ON WATER FLOW

Hanor A. Webb, Nashville, Tennessee.—A water pipe of considerable length (as one mile) leads from a reservoir to a faucet outlet, where a gauge registers a moderate pressure (as 10 pounds). When the faucet is opened the water flows instantly. Is there also *instantaneous movement* at the reservoir end of the pipe? At all points along the line?

A mere "yes" or "no" answer will not satisfy me—I have received each from physics professors. The answer—and explanation—should take into account (a) the incompressibility of water; (b) the inertia of the mass of water filling the long pipe; (c) the transmission of a wave (if any) of lowered pressure backward along the pipe; (d) other factors that apply.

Window Wall is described as the largest horizontal sliding window wall ever designed. Made primarily for apartments, hospitals, office buildings and other large commercial structures, the partition-to-partition aluminum window is made in heights up to five and one-half feet and widths as desired.

ELEMENTARY SCHOOL SCIENCE CURRICULUM CONSTRUCTION IN YPSILANTI, MICHIGAN*

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During the years 1950–1953 graduate students in elementary science under the co-operative program between the University of Michigan and Michigan State Normal College frequently selected for research problems dealing with elementary science curriculum construction and revision. Usually they chose problems dealing with specific areas and grades, as, for example, weather for the third grade.

In 1953, a course entitled Science Curriculum for Elementary Schools was included among the graduate courses for the Masters in Education offered by Michigan State Normal College on its own graduate program. Much serious and excellent work has been done by the students in this class, usually working on their own immediate curriculum problems.

About this time, the teachers of the Ypsilanti Public Schools began a study of curriculum needs in their own school system, and grouped themselves into area committees, according to their interests, such as social studies, language arts, science, and others. Several of these teachers enrolled in the Science Curriculum course and worked on the science curriculum for their own grade levels.

For the summer session of 1954, a special course was offered for Ypsilanti teachers by Michigan State Normal College, in which they might obtain either graduate or undergraduate credit. This course was known as 595 Y-Ypsilanti Workshop in Curriculum Building, under the direction of Dr. John McGill. It should be noted here, that the Ypsilanti Public Schools paid the fee for the teachers from their school system who took this course. Six students indicated their desire to work in elementary science and much intensive and thorough work was done in the elementary science laboratory under my direction, during the six weeks of summer school.

During the year 1954–55 five students worked during the two semesters. For the summer of 1955 one student devoted her entire attention to bibliography, and at the present time two students are working on supply and equipment lists.

To date, more than a dozen teachers have worked at least one semester on the revision and earned two hours of graduate credit; a few have worked four semesters and earned eight hours of graduate credit, including six hours of Field Problem courses.

* A symposium on the Elementary School Group program of the Central Association of Science and Mathematics Teachers at Detroit, November 26, 1955.

All available science readers, courses of study, reference books, children's books and other curricular materials have been examined and evaluated. Many experiments have been checked and re-checked. Many sets of concepts have been actually "tried-out" by teachers in their own teaching situations. Teachers for the various grades worked on materials for their grades. Omissions in the course of study represent grades and areas in which teachers have not yet appeared in the graduate classes who were teaching those particular grades, or who were interested in those particular areas.

It should be noted that each area group of concepts is followed with suggested conservation concepts. These are vital, almost personal concepts that affect behavior and relate the child personally to weather, plants, or animals, for example. It is our philosophy that conservation cuts across all fields of human interest, and, therefore, has its definite place in every area of elementary science. The conservation concepts should specifically relate the individual with the particular area of science, indicating the desired behavior and responsibilities for the individual, depending upon the grade level. We feel that concepts of this nature should be definitely labeled as conservation concepts.

Concepts for each grade were selected and then arranged side by side; early elementary, grades one, two and three; later elementary, grades four, five and six. These concepts were carefully scrutinized in terms of scope and continuity. This scrutiny was critical, selective and often creative, to the extent of the complete re-writing of a set of concepts.

The concepts were listed in a left-hand column. In a parallel right-hand column, activities were suggested that the teacher might use to teach the concept. References were indicated for the sources of concepts and activities.

Weather, heat and light are put into one set of concepts for grades one to three. There are scope and continuity charts, as well, for plants and animals. The animal materials include insects, birds and mammals. One set of concepts each are given for magnetism, sound, electricity, rocks and minerals and astronomy. The need for such concepts might arise in any of the three grades, but seem not to arise in all three for any given set of children in the early elementary grades. The teacher can thus make use of the materials given, best suited to her grade level.

In the later elementary grades, scope and continuity charts are found for weather, plants and animals. Again, animal materials include insects, birds and mammals. There are concept outlines of a resource nature on amphibia, reptiles and fish, heat, electro-magnets and rocks and minerals. There are some sets of concepts and activi-

ties completed for the seventh grade. A brief outline on Life Through the Ages is also included, with references given for fourth through sixth grades. It is merely a "frame of reference" with the accent on Michigan.

A committee of Ypsilanti teachers are working on preface, aims and objectives, philosophy, and other portions. One of these days, the course of study will be completed. But it is my hope that it will never be produced in more than a "duplicated" form. A printed form is too permanent. A duplicated form can be more easily changed and improved. And we should start revising it, just about the time it is completed. Already, suggestions have been made, that sketches would add a great deal. And we can now stand off and view it more objectively. We can see where we can strengthen our weak spots, and better our best portions. A course of study should never be really finished. It must be constantly growing and changing, expanding and adjusting to meet the needs of today's school children. And we must always keep in mind that today's grade school children are the present junior citizens and the future senior citizens of a world whose science implications of atom and space will undoubtedly exceed even the impossible attainments of today's scientists. We must keep our science materials for elementary children in step with the current world situation. We dare not lag, for junior and senior high school science must be built on our foundation of elementary school science. This science foundation must be solid and secure, based on concepts brought sharply and clearly into focus by means of the most effective pupil activities and experiments that we can find.

But these concepts must also be translated into changed behavior through constant and repeated emphasis on their conservation aspects. The ability of the individual to interpret knowledge and concepts in terms of that kind of changed behavior that brings about "the greatest good for the greatest number for the longest time" is the behavior that characterizies the well-adjusted citizen of a world really intent on democracy.

Bibliography

The listing of the curricular materials used for this revision would cover several pages. Already many have been replaced by newer and better curriculum guides, new editions of elementary science readers, and better and more beautifully-illustrated references books. I shall only suggest a few of the most helpful sources of current curricular materials.

1. Merritt, Eleanor and Harap, Henry. *Trends in the Production of Curriculum Guides:* a Survey of courses of study published in 1951 through 1953. Nashville, Tennessee: Division of Surveys and Field Services, George Peabody College for Teachers, 1955, 44 pp. $.50 (a similar survey was made for the years 1948–1950; perhaps one will appear for 1954–1955).

2. ASSOCIATION FOR SUPERVISION AND CURRICULUM DEVELOPMENT. "List of Outstanding Curriculum Materials 1951–1954," Washington, D.C.: *National Education Association*, 1955. (1201 Sixteenth Street, N.W., Washington 6 D.C., $.75.)
3. CURRICULUM COMMITTEE, LOUISVILLE PUBLIC SCHOOLS. *Source Book of Science Experiences for Elementary School Children*, Louisville, Kentucky: Louisville Public Schools, 1954, Vol. I (Primary level), pt. 1, Weather and Climate, The Story of the Earth, Living Things, 305 pp. $3.05; pt. 2, Health and Nutrition, Machines and How They Help Us, Magnets and Electricity, Light and Sound, 195 pp., $1.95.
Vol. II (Intermediate level), pt. 1, Weather and Climate, The Story of the Earth, 320 pp., $3.20; pt. 2, Light and Sound, Magnets and Electricity, Machines and How They Help Us, 310 pp., $3.10. pt. 3, Living Things, Health and Nutrition, Matter and Energy, 360 pp., $3.60. (Exceedingly helpful.)
4. RAGAN, WILLIAM B. AND STENDLER, CELIA BURNS. *Modern Elementary Curriculum*, New York: The Dryden Press, Inc., 1953. 548 pp.

HISTORY OF THE SCIENCE CURRICULUM BUILDING IN YPSILANTI PUBLIC SCHOOLS

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In 1952, the staff of teachers in the Ypsilanti Public School System began to feel the need of a new philosophy put in writing to guide them in their teaching. Their program had taken them a long way from the old traditional school and its methods of teaching. As the population, schoolrooms, and personnel staff increased in number, the adminstration realized that something concrete should be done to help. With this in mind, area meetings were organized on school time to work out the problems in that specific area of study. At the end of the first year a great amount of work had been achieved. One of the most helpful accomplishments was a survey of units taught in the respective fields of study in each grade throughout the school system.

Because science was not required in the elementary schools, it was found that a few teachers were teaching no science at all, a greater number were teaching it incidentally, while a fewer number were giving scheduled time for it during the week. To orient it basically throughout the system, it was felt that a science guide should be written by our teachers to fit our own particular needs. This would help new teachers as well as busy tenure teachers.

With the help of administration, scholarships were given to interested teachers for their work in cooperation with Michigan State Normal College. It was indeed fortunate that the solution to our

needs originated simultaneously with those needs, for it was at this time that the Normal College devised the field study course and work shop of which Dr. Curtis spoke.

All of us, from the pupils to the total community, are deeply indebted to Dr. Curtis personally for her expert supervision of what we believe is an excellent piece of work. We have compiled units in both lower and later elementary grades, stating the concept as well as many activities to develop it. The volume is extensive and varied. We do not expect any one teacher to use all units, nor do we expect all teachers to use the same units. We hope this guide book is extensive and varied enough to meet the needs and interests of any group of children in the school system. We also expect enough units to be of interest, that from one year to the next, a continuous spiral of concepts will be attained by each pupil.

This is how we hope our teachers will use the guide book. A group of fifth grade pupils have become interested in the sudden change in the weather. The teacher wishes to take advantage of their interest and teach them some basic natural laws about weather.

The fifth grade teacher then should turn to the guide, find the unit on weather, and read the concepts compiled for fourth, fifth and sixth grades. You will notice that these are written for all three grades at the beginning of each unit. The purpose is two-fold. First, she can readily see the continuity of the concepts she expects to teach her own group, as well as, second, she has before her the concepts that may have already been taught them and the ones that are usually of interest to them in the advanced year. On the following pages, she will find the concepts for individual grades as well as activities to develop them. In many instances, the activities include complete instruction of how to perform the activity. After each activity, the reference title and page number is given so the teacher or the pupil can turn to the original book for further study.

Suppose the teacher has begun her unit on weather and on this particular day wishes to teach about the atmosphere. She reads that they may have studied atmosphere in the fourth grade. However, with a quick review, she can bring to mind the previous concepts or teach them anew to those who may not have already learned them. By looking at your first page, you notice that fourth grade concepts tell about the world having atmosphere that extends into space for many miles and that it is a mixture of gases, oxygen being the most important to all living things. Some pupil may recall an activity that was done the year before and may want to do it individually this year. This is an excellent opportunity for the teacher to develop in an individual, confidence in himself, further interest, and the satis-

faction of having learned. It is also gratifying to the slower learner who can be studying the same material as the rest of the class, although it is on a lower level.

Having reviewed atmosphere, the teacher is ready to expand the concepts. Fifth grade guide on atmosphere tells how it is divided into two layers, the troposphere and the stratosphere, how the clouds are in the troposphere, and a more detailed composition of the atmosphere. Activities include discussions on use of these gases by man, making charts, and doing experiments to show the need of oxygen for combustion as well as how to obtain carbon dioxide.

The teacher will notice that a third layer of atmosphere is included in the concepts for sixth grade and will refrain from teaching it unless the questioning of the pupils warrants it. Through our study, we have found that most children are not keenly interested in electrical charges, radio waves, or air masses until the sixth grade. However, the teacher is to understand that the advanced pupil is not to be limited in his scope of interest, and she may want to direct him individually to reference material that will answer his questions. This she may obtain from the guide.

We believe the guide achieves its purposes in many ways. In the first place, its scope of interest is so wide that it cannot help but answer the needs of any of our pupils whether they be scientific, academic or social. In this particular unit on weather, a challenge of interest is developed when the question is raised, "How far has man been able to venture into the atmosphere?" The pupil also is made to realize the problems existing before scientific development can take place. An admiration of the ability and the patience of scientists is acquired.

Through the development of activities, a scientific mind comes into maturity. They learn to begin with the known facts, collect further data, and resolve their findings into concrete conclusions, always mindful to check and recheck. He evaluates his own opinions as well as those of others. By constructing a barometer, the child can observe for himself, the relationship between temperature and air pressure. Then he may turn to a well known author or a weather report for verification of his conclusions.

Probably the greatest achievement desired by a science teacher is to plant the seeds for a future scientist, in the mind of some student. This is an accomplishment for which no material wage can compensate. We believe that with the help of this guide, no schoolroom will be able to dampen the enthusiasm of students whose teacher uses it.

A GUIDE FOR THE STUDY OF ELEMENTARY SCIENCE

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So often when we launch a project such as this, our search is not for subject matter content but rather for techniques and methods of breaking down the things we know to the child's level. However, in the final analysis we gain not only these techniques but also a lot of valuable knowledge we did not possess before. This has been my own personal experience.

The purpose of writing this guide is four-fold:

1. To meet the needs of today's children. Youngster lives are being touched daily by many things as astronomy, air-space travel and atomic reaction, to mention a few, and they ask many questions which we should be able to answer or at least know where to find the answer. Children want and need to know the "how" and "why" of things.

2. To supply our total personnel of elementary students with a more equal opportunity of gaining the basic fundamentals necessary to cope with the scientific concepts presented in Junior and Senior High Schools.

3. To give teachers the confidence to teach a subject which is widespread in interest and complicated in scope.

4. To place compiled valid information in the hands of all the teachers to serve as a guide, but not to limit or stifle their own ingenuity.

The major purpose of the guide itself is to give students understandings, appreciative attitudes, skills and methods of thought which will help them adjust to their social and natural environments through knowledge, techniques, evaluation and exploration.

Knowledge will be gained through observation and research, in fact, from all his experiences, but knowledge alone is not enough.

Techniques are procedures and skills which teach the children the importance of making decisions after careful checking, and also of accepting proven facts furnished by reliable scientists.

Evaluation is achieved by guiding the children to better understandings of the world in which they live, by fostering appreciation of the inter-relationships within that world, and by making intelligent application of these understandings and appreciations to themselves and their environments.

Exploration is that portion of the guide which develops new interests and activities for the children during their leisure time. It causes them to not only ask the questions "How" and "Why" but also creates a desire to seek the answers for themselves.

This guide has been constructed on a spiral sequence of ideas, both in scope and continuity. We began with kindergarten as our base and as the children advanced the area of subject matter gradually became broader.

In the third grade we took the unit, *Plants Get Ready for Winter*. This unit was introduced with the poem "Trees." After an interesting discussion of the trees being plants, the third graders went on field trips and collected specimens of deciduous and evergreen trees. Spatter prints were made of each kind and also crayon etchings of some. These are on display in the convention exhibit room.

The class was led to see that plants have enemies: animals, weather, man. Conservation was brought in by discussion of ways of protecting forests, and why this protection is necessary. A Boy Scout was invited to visit the class and he talked to them about Nature Trails, putting out campfires and thereby preventing forest fires. The class then made drawings of trees, labelling the crown, trunk, and roots. They were given worksheets entitled, "Trees in Every Day Living," which was a continuation of the conservation theme. This led naturally to discussion of how plants give us food, shelter, clothing and a good deal of our transportation and communication. The class gathered pictures and made posters of these under the above mentioned four headings. In gathering foods for the poster it was very easy for the children to see that we eat different parts of many plants as the roots, stems, leaves, fruit and seeds.

In addition to plants being very necessary to life, the class also discussed how some plants were for beauty. The teacher had a wild flower chart which she showed the class and explained that they are divided into three groups: those you may pick freely; the ones you may pick in moderation; and those which are not to be picked at all especially near towns or camps. The class gathered a few of the possible ones in the Fall and are looking forward to gathering Spring varieties. With the use of Scotch tape they mounted these real specimens on construction paper.

There were several other things that the third grade did that I did not list. Whereas, they gained a lot of useful information, they also had a lot of fun doing it.

Since they had previously had a unit the Spring before on "Seed Dispersal," after a brief review it was quite easy to move into the Plant Unit.

When you read the Science Guide you will find that all of the above activities are not listed but the teacher was able to supplement it with her own ideas.

The materials displayed here at the CASMT display room were done by Mrs. Erwin's third grade class of Harriet School, Ypsilanti.

EXCERPTS FROM YPSIPLANTI PUBLIC SCHOOLS COURSE OF STUDY IN ELEMENTARY SCIENCE

SCOPE AND CONTINUITY OF CONCEPTS CONCERNING SCIENCE

PLANTS

First Grade	Second Grade	Third Grade
1. Food from plants is gathered and stored in the fall. 2. Grass plants hold soil. 3. We should save all the leaves that fall from the trees. 4. We use plants for food, clothing, and homes.	*Conservation of Plants* 1. Plants must have our care in order to have enough: a. Water b. Sunshine c. Air d. Room e. Good Soil 2. Leaves of plants must have sunshine, in order to make the food for the plants. 3. Plants must get their water and minerals from the soil. 4. We eat many parts of a plant. a. Roots e. Flowers b. Stems f. Fruits c. Leaves g. Seeds d. Buds 5. People plant seeds so that plants do not disappear.	1. Each kind of plant has a way of getting ready for winter. 2. We must know that plants have enemies. a. Animals b. Weather c. Man 3. In order to protect our forest of trees: a. We never play with matches or fire. b. We are careful to cover our campfires with soil before leaving the camp ground. 4. We should not mis-use or waste plants. a. We should not break branches from a tree. b. We may take a few wild flowers but not all. c. We leave some flowers to produce seeds for next year. 5. Leaves and stems of plants die down and help to make good soil. 6. Plants keep soil from washing away. 7. We have a few plant enemies which we should know. a. Poison ivy b. Weeds—plants which are out of place

CONSERVATION OF PLANTS—THIRD GRADE

Concepts	*Activities and Validations*
1. Each kind of plant has a way getting ready for winter.	1. Make crayon prints of leaves from deciduous trees, and from needles of evergreen trees. Notice the difference in length of time leaves remain on the trees. Take pictures of trees and other plants, showing contrast in method of getting ready for winter. Place pictures in class nature notebook. *Louisville Course of Study*—Volume I, Part I—194.
2. We must know that plants have enemies a. Animals b. Weather c. Man 3. In order to protect our forest of trees: a. We never play with matches or fire. b. We are careful to cover our campfires with soil before leaving the campground.	2. Discuss ways that animals eat plants in our gardens. Children may make up a play about the way weather helps or harms plants. Make posters showing that man takes more than he needs. A group of children may give a talk to younger children, stressing the need for wise use of plants, and taking just what we need, after we have asked permission of the owner. Discuss nature trails, where flowers may be studied, but not picked. *Louisville Course of Study*—217. 3. Invite a Boy Scout and a Girl Scout to the classroom to give talks on the reason for being careful with campfires. Conduct a poster contest stressing safety features in use of fires. *Louisville Course of Study*—226.
4. We should not mis-use or waste plants. a. We should not break branches from a tree. b. We may take a few wild flowers, but not all. c. We leave some flowers to produce seeds for next year.	4. Make litter bags to help keep parks and yards clean. Show pictures of rare plants which should not be picked. Visit a nature trail and notice wild flowers. Re-visit at a later date to see the rate of growth. Craig, Gerald, *Science Around You* (2) 104. Dowling, Thomas, *Learning Why* (3) 68. *Audubon Junior News*, Nov.-Dec. 1953, 8.
5. Leaves and stems of plants die down and help to make good soil.	5. Observe that compost makes a carpet in the woods. Use compost pile to place over the school garden. Craig, Gerald, *Science Around You* (2) 22.
6. Plants keep soil from washing away.	6. Read *The Soil That Went to Town*, U. S. Dept. of Agriculture, Soil Conservation Service. Plant grass or other plant cover in places in yards where water washes soil away. Smith, F. C., *First Book of Conservation*, 67.
7. We have a few plant enemies which we should know: a. Poison ivy b. Weeds—plants which are out of place	7. Invite a person from the Conservation Department to explain some plant enemies and tell children how to recognize them. Use Film-Conservation for Beginners (5 V E) 6 reel, color. Dowling, Thomas, *Seeing Why* (2) 19. Dowling, Thomas, *Learning Why* (3) 54.

SCOPE AND CONTINUITY OF CONCEPTS CONCERNING SCIENCE

Weather

Fourth Grade	Fifth Grade	Sixth Grade
1. The atmosphere tends to press equally in all directions. 2. Weather is the condition of the atmosphere at the moment. Climate is the usual weather over a long period of time.	1. A barometer is an instrument that measures atmospheric pressure. 2. A falling barometer usually means a storm, a rising barometer indicates fair weather.	*Weather Bureau* 1. The work of the Weather Bureau consists chiefly of the following services: a. Making weather maps and forecasting the weather b. Making special warnings of storms, frosts and floods c. Sending out warnings of help to aviators. d. Making special forecasts in connection with forest fires e. Making other special forecasts of various kinds f. Keeping records of the weather g. Publishing crop reports h. Studying weather and publishing accounts of anything new that is found 2. Since weather means various things, the weatherman uses many kinds of instruments such as: a. Barometer—to measure air pressure b. Weather vane—to point to the wind's direction c. Thermometer—to measure temperature d. Psychrometer—to measure the amount of moisture in the air e. Anemometer—to measure the velocity of the wind f. Hair hygrometer—to measure the amount of moisture in the air g. Rain gauge—to measure the amount of rainfall

Weather—Fourth Grade

Concepts	*Activities and Validations*
1. The atmosphere tends to press equally in all directions.	1. Blow up a balloon. Why does the balloon take a round shape? Demonstrate that air exerts pressure in all directions. Materials required: a. Five gallon square gas can well cleaned b. A cup of water c. A source of heat Steps: a. Remove cap from can and pour in water and do not recap can b. Place can over source of heat and allow water to come to a racing boil. c. Remove can from heat and recap immediately. d. Allow time for steam in the can to condense, creating a partial vacuum. Air pressure will crush in all sides of the can showing that air pressure presses in all directions. Craig, G. S., *Exploring in Science*, 1946, pp. 57–63. Parker, B. M., *Our Ocean of Air*, 1941, p. 16.
2. Weather is the condition of the atmosphere at a moment. Climate is the usual weather over a long period of time.	2. Have the children refer to the weather chart being kept by the class Note the number of days in which the sky was overcast. These are days of cloudy *weather*. Note the number of days in which precipitation is recorded. The *weather* for these days is said to be snowy, rainy, or wet. Have the children interview their grandparents or other older persons in the community regarding weather conditions existing 50 or more years ago. Compare their reports with the weather chart. In this manner they (the children) can see how *climates* are established. Personal experience.

WEATHER—FIFTH GRADE

Concepts	*Activities and Validations*
1. A barometer is an instrument that measures atmospheric pressure.	1. a. Fasten the bottom half of a round ballon air tight over the mouth of a quart milk bottle by means of a doubled rubber band. b. Put some glue on the balloon rubber from middle to one side. c. Put one end of a soda straw in the glue, being sure that the end of the straw is at the middle of the rubber. Put a light weight on the straw and rubber until the glue holds. d. Put a match stick into the other end of the straw to serve as a pointer. Place this barometer with its pointer near a piece of paper pinned to the wall. Mark the position of the pointer each day. It rises when the atmospheric pressure rises, and vice versa. This barometer is accurate only when its temperature is constant. C. J. Lynde, *Science Experiences with Home Equipment*, p. 19.
2. A falling barometer usually means a storm, a rising barometer indicates fair weather.	2 Use the barometers brought in or made by class to record daily the air pressure on a weather chart. Observe the change in weather. Craig, G. S., *Working with Science*, 1946, pp. 213–216.

WEATHER—SIXTH GRADE

Concepts	*Activities and Validations*
Weather Bureau 1. The work of the Weather Bureau consists chiefly of the following services: a. Making weather maps and forecasting the weather. b. Making special warnings of storms, frost, and flood c. Sending out warnings of help to aviators d. Making special forecasts in connection to forest fires e. Making other special forecasts of various kinds f. Keeping records of the weather g. Publishing crop reports h. Studying the weather and publishing accounts of anything new that is found	1. *Ask the Weather Man*, Parker, p. 4. Keep track of the weather forecasts for a week. Also keep track of the weather and see how many were right. Get a calendar in which the weather has been forecast for the year. Check the weather forecasts for every day for a week. How many were right? Discuss how weather warnings might help farmers. Discuss how airplane pilots might use the Weather Bureau. Talk to a pilot about the warnings he watches for from the Weather Bureau. Write to the Conservation Dept. and ask for information on the Forest Rangers and how they use the news from the Weather Bureau. Discuss with the orchard owners how the Weather Bureau helps them. Take a visit to a Weather Bureau Station. What new warnings have they given out lately?
2. Since weather means various things, the weatherman uses many kinds of instruments such as: a. Barometer—to measure air pressure b. Weather vane—to point to the wind's direction c. Thermometer—to measure temperature d. Psychrometer—to measure the amount of moisture in the air e. Anemometer—to measure the velocity of the wind f. Hair hygrometer—to measure the amount of moisture in the air the times the temperature is low g. Rain gage—to measure the amount of rain	2. *Ask the Weatherman*, Parker, pp. 5–16. a. Construct a barometer as directed in: *Elem. School Science*, Blough, p. 202. or: Fill a glass jar about 1/3 full of water. Put a little water into a pop bottle and then invert the pop bottle in the pint jar. If there is enough water in the pop bottle, the level of the water in each container will be about the same. The pressure of air on the water in the pint jar will cause the level of the water to rise in the neck of the pop bottle. b. Construct a weather vane according to directions in: *Everyday Weather*, Schneider, pp. 154–156. c. Recall how you made a red and white ribbon thermometer in lower grades. d. Construct as many instruments as possible and set up your own Weather Station. *Everyday Weather*, Schneider, pp. 125–171.

DRAFTING MACHINE

Drafting Machine is an imported, Swedish-made instrument for performing any graphic operation requiring a T-square and triangle. The steel and plastic device holds any angle and its complement. The protractor head reads from 90 through 0 to 45 degrees with automatic quick-set lock every 15 degrees.

THE ROLE OF THE JUNIOR COLLEGE AS IT RELATES TO THE EDUCATIONAL NEEDS OF INDUSTRIAL TECHNICIANS*

TRACY B. NABERS
Chrysler Institute of Engineering, Engineering Division, Chrysler Corporation, Detroit, Mich.

The topic which you have suggested that we discuss today is a timely one. Education and industry are faced with two facets of the same problem. Industry has a shortage of technical personnel, and educators are confronted with the problems involved in trying to meet the overwhelming needs and demands for more education.

I recently read a *Detroit News* article written by Asher Lauren in which he states, "Government officials have been stressing that unless training programs are stepped up, the nation faces a costly shortage of skilled workers early in the 1960's. Some employers are complaining that the shortage is already here."[1] Of course, the Junior College is concerned only with the educational and training needs of that portion of the skilled workers who are classified as technicians. But, many of the same factors creating a shortage of skilled workers operate to cause a greater demand for engineers and technicians. Recent advancements in our technology have accelerated the employment of engineers so that in less than a generation the proportion of engineers in industrial employment has more than doubled. The number of young people now in our engineering schools is generally considered to be inadequate. Authorities estimate the needs for supporting technical personnel to be from three to as many as seven technicians per engineer. If the shortage of engineers is serious, then the technician problem calls for prompt and vigorous action on the part of industry and education.

More jobs today require education above the high school level. The trend seems to be toward more employees entering industry at higher levels, thus requiring more pre-employment training. For example, the machine oiler of a few years ago is becoming a lubrication engineer in the highly automated factory. What are some of the implications? Our first thought is that this additional education costs money. The financial burden of our schools is magnified. There is currently a great deal of study and discussion among educators and others concerning the best solution to this dilemma. Not being an expert on school finance, I do not know the answer; however, being

* Presented at the Junior College Group Meeting of the Central Association of Science and Mathematics Teachers, Inc. Detroit, Mich., November 26, 1955.

[1] Lauren, Asher, "Nation's Boom Shows Need for More Skilled Workers," *The Detroit News*, November 20, 1955, p. 24-B.

the parent of two children I am faced with the prospect of providing for their education beyond high school. In regard to this problem, the October 1955 issue of *Changing Times* states, "College costs are about twice what they were 20 years ago and are still going up. Each year, unfortunately, about 100,000 qualified high school seniors who want to attend college don't go because they lack the money."[2] Some of these young people are no doubt potential material for engineering and technician programs. The same article indicates that a recent survey by the U. S. Office of Education found expenditures ranging from $200 to $5000 a year for a college education. In the article just referred to, it is stated, "The $200 student kept costs down by living at home, attending a free municipal school and spending money for only the barest necessities."[3] You are probably thinking that the expenses for your college education were well above $200 a year.

Have you considered how many of the high school graduates could profit from training in your Junior College? Statistics indicate that nearly half the graduates of our secondary schools could profit from education at the college level. As young people gain greater perspective concerning the opportunities offered by work as an industrial technician, no doubt they will turn more and more to those institutions of higher learning which offer a two-year program which can prepare them for responsible and satisfying employment in industry.

It seems rather obvious to me that if we are to understand the educational role of any institution, we must not only know the product which the program is to produce, but also we must properly appraise the material upon which our professional energies are to be expended. For purposes of this discussion let us divide people into two distinct groups. At one extreme we have the "doers," at the other the thinkers or "theorists," In which camp does the potential technician belong? Although he may very well fit into either group, he generally is the type of individual who is impatient with theory unless he can see a direct application. He is very capable and very much "at home" in what he considers to be practical situations. He probably is over anxious to assume an independent and adult role in society. For this reason, he desires a short course which will prepare him as a specialist in industry. The problem is also complicated by the fact that some of the students enrolled in a Junior College terminal program are "planned terminals" while others are not. One follow-up study indicated that about eleven percent of the graduates of a technical program continued their study of engineering in a four-year program.

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[2] *Changing Times—The Kiplinger Magazine*, "What College Really Costs," October, 1955, p. 29.
[3] *Ibid.*, p. 29.

What is a technician? What are some of the viewpoints concerning the education of technical and scientific industrial employees? If one were to judge what a technician is by an analysis of the programs of technical institute type we would have to conclude that he is many things at one time. Some programs place him nearer the skilled worker; other programs place the technician nearer the professional engineer or scientist. However, statements concerning a technician and what he does indicate a great deal of uniformity of thought. For example, a brochure published by Henry Ford Community College, Dearborn, Michigan, makes a typical statement: "The technician is the man between the skilled worker and the engineer. As an important member of the industrial team he works with both groups. The engineer uses his knowledge in planning, research, design and development. The technician is concerned with the how to do it, and uses his knowledge to perform operations, calculations, run tests, make estimates, and prepare plans." Again we have somewhat the same viewpoint expressed by Mr. C. S. Jones, President, Academy of Aeronautics, when he wrote, "The engineer plans, the technician makes and does. The engineer creates, the technician operates. Programs of instruction are briefer and more technical in content than professional curriculums though both are concerned with the same general fields of industry and engineering."[4] Elizabeth Herzog and Paul Sheatsley in an article titled "Science Education, As the Scientists See It" draw an interesting comparison between the viewpoint of the industrial scientists and the university scientists. They write, "Differences between opinions expressed by university and industrial scientists, for example, consistently reflect differences in orientation between basic and applied research."[5] They later indicate, "Industrial scientists . . . are more likely than the rest to insist on the need for practical application of the material taught, as opposed to an abstract and theoretical approach."[6] What relation does this have to the training of industrial technicians? If this viewpoint is generally held by the industrial employers and supervisors of science graduates, then they must hold even more firmly to the proposition that their technicians be well versed in the applications of scientific knowledge. My own experience has led me to believe that this assumption is not necessarily true. I know industrial research as well as test and development personnel who think that the best technician is a young graduate engineer who enthusiastically looks upon his work as a technician as being his engineering internship. However, other super-

[4] Jones, C. S., "The Technical Institute and Some of Its Problems," *Technical Education News*, Vol. XIV, 1-1954. p. 2.

[5] Herzog, Elizabeth G. and Sheatsley, Paul B., "Science Education, As the Scientists See It," *The Educational Forum*, Vol. XII, No. 4, May, 1948, p. 413.

[6] *Ibid.*, p. 419.

visors prefer the mechanic who has worked diligently, has studied during his evenings and thus has advanced to the technician classification. The best answer to the problem we have posed seems to be a knowledge of where, and in what kind of jobs the school's technical graduates will be working. Is it a production or research situation? What is the general educational background of the people for whom the technician will be working? How has the job previously been filled? How little "practical" knowledge will the job situation tolerate?

We could discuss at great length the varied viewpoints concerning "practical" or applied knowledge and theoretical knowledge and still not arrive at our final objective. So let us take a look at some existing technician type programs.

Group I	Group II
Metallurgical	Electronics & Electrical Power
Industrial	Automotive
Chemical	Tool Engineering
Architectural (Design)	Aeronautics (Maintenance)
Tool Design	

An analysis of those programs in Group I seems to indicate that the general character of the classroom activity and the subject matter places them a little nearer the academic, and the basic knowledge draws extensively on the basic sciences. In the second group, the emphasis probably should be placed on shop or work experience. That is, more attention given to the "how" rather than the "why." It is, however, recognized that such a classification would not always hold true. It is our opinion that whatever his specialty may be, a technician should have a good understanding of the basic sciences. The Chrysler Institute of Engineering is currently planning a technicians' orientation program. We hope to hire graduates of technical institute programs and others who have had at least two years of technical training. The following courses have been proposed: (1) review of mathematics, (2) design of experiments, (3) automotive instrumentation, (4) mechanical drawing, (5) freehand drawing, (6) engineering organization, (7) safety, (8) statics, (9) fluid mechanics, (10) report writing, (11) strength of materials, (12) dynamics and (13) mechanisms. In this program the trainee would be excused from similar courses which he has already taken. Our plan is to have the engineering specialist work for six hours a day in one of our engineering laboratories and attend class for two hours at the Chrysler Institute of Engineering. You will no doubt note that this is an abbreviated program. This is possible because we expect those who are selected for training to have already studied mathematics and other basic science courses. However, these courses do indicate the type

of studies we feel are important for our situation. A committee of the Technical Institute Division of A.S.E.E. made an analysis of the contents of courses of the technical institute type accredited by the Engineers' Council for Professional Development. They found that the average percentage of time devoted to basic science was 23.2, technical specialty 53.4, allied technical specialities 14, administrative and managerial 4, and general subjects 5.4.[7] It is also stated that "In view of the fact that modern business places an appreciable amount of importance on training in administration, management, and English, it appears that more time should be devoted to such subjects in training the engineering technician."[8]

We have briefly reviewed several of the many factors influencing the role of the junior college in its efforts to train industrial technicians. But, the junior college today is not the same junior college it was a few years ago. In the last two decades new concepts concerning its function have evolved rapidly. Therefore, in the remaining portion of this discourse I would like to use the term "junior college" as meaning a two year senior college preparatory institution. The community college is an institution composed of two year curricula, some of which are senior college preparatory, others being terminal in nature. Many excellent technician training programs are being offered by several types of educational institutions. However, what are some implications resulting from the concepts and data presented in this paper.

Conclusions and Implications

1. The junior colleges and community colleges are in an ideal position for serving the local community and the nation by making available to larger numbers of our youth, effective technical education above the high school level. This can be at a minimum cost to the student, making it possible for industry to gain technical services from youth who might otherwise have been counted among our losses of human resources.

2. It is important that these institutions pattern their program to fit the needs of their students and the local needs of the industrial community. Due to divergent opinions concerning the best training for a technician, it seems imperative that a joint business, industry, and education committee be established to study the community needs.

3. Since programs of instruction are shorter, the course content must be more to the point. The mathematics and science courses of

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[7] Karl O. Werwath, "Curriculum Development," *Technical Education News*, Vol. XV, No. 1, 1955, p. 15
[8] *Ibid.*

the traditional junior college can probably be most effective when the teacher is able to relate theory to practice.

4. Certain technology programs, due to the nature of the work and the facilities needed for instructional purposes, can probably be as successful in the traditional junior college setting as any other. However, other programs probably should be offered under the community college or technical institute type of organization.

Much of the current literature emphasizes the desirability of applied knowledge and manipulative skills in the training of industrial technicians. Education in human relation skills and the art of living generally receive comparatively little attention. It is probably too early for industry and educators to judge if the technician is deficient in these latter skills. However, it is conceivable that in the future, technician programs may be accused of overemphasis of applied technical skills just as engineering education was in recent years.

PROBLEM DEPARTMENT

Conducted by Margaret F. Willerding

Harris Teachers College, St. Louis, Missouri

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the Department desires to serve his readers by making it interesting and helpful to them. Address suggestions and problems to Margaret F. Willerding, Harris Teachers College, St. Louis, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Solutions should be in typed form, double spaced.

2. Drawings in India ink should be on a separate page from the solution.

3. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

4. In general when several solutions are correct, the one submitted in the best form will be used.

2503. *Proposed by Brother Felix John, Philadelphia, Pa.*

In an equilateral triangle, the circumradius R equals twice the inradius r. Given, in triangle ABC, that $R=2r$. Prove, if possible, that the triangle is equilateral.

Solution by C. W. Trigg, Los Angeles City College

Method I. By Euler's Theorem, the distance between the circumcenter and the

incenter is given by: $d^2 = R(R-2r)$. Hence, when $R = 2r$, the circumcircle and the incircle are concentric. Then ABC consists of three congruent isosceles triangles with legs R and altitudes r to the bases. It follows immediately that ABC is equilateral.

Method II. It is well-known that the area of ABC,

$$\triangle = abc/4R = \tfrac{1}{2}(a+b+c)r = \sqrt{s(s-a)(s-b)(s-c)},$$

where $2s = a+b+c$. Hence $R = abc/4\triangle$ and $r = 2\triangle/(a+b+c)$. Now if $R = 2r$, we have

$$abc/4\triangle = 4\triangle/(a+b+c).$$

$$abc(a+b+c) = 16\triangle^2 = 16s(s-a)(s-b)(s-c)$$

$$abc(a+b+c) = (a+b+c)(b+c-a)(a-b+c)(a+b-c)$$

$$1 = \left(\frac{a+c}{b}-1\right)\left(\frac{b+a}{c}-1\right)\left(\frac{c+b}{a}-1\right).$$

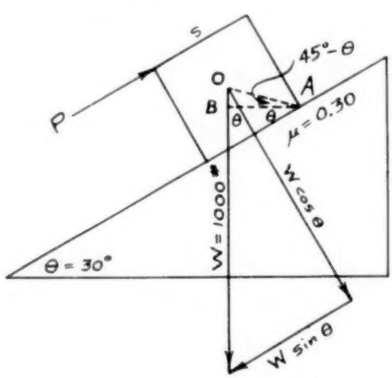
In order that each factor in the right member may equal one, $a = b = c$.

Solutions were also offered by Carrie Luther, Oneonta, N. Y.; W. R. Talbot, Jefferson City, Mo.; and Walter R. Warne, St. Petersburg, Fla.

2504. *Proposed by Julius Sumner Miller, El Camino, Calif.*

A homogeneous cubical block rests on the incline as shown. The coefficient of friction is 0.30. A force P is applied at the upper edge of the block and parallel to the plane. Will the block slide or tip?

Solution by the Proposer



Consider the block of edge s on the verge of tipping upward about the corner in contact with the plane. For *rotation* about this point we write

$$1000 \times s/\sqrt{2} \times \cos 15° = P \times s,$$

whence $P = 685$ lbs., very nearly. (Or, if you please,

$$1000 \times \cos 30° \times s/2 + 1000 \times \sin 30° \times s/2 = P \times s,$$

where we resolve the weight of the block into components normal and parallel to the plane).

For *slipping up* the plane we write

$$P = 1000 \times \sin 30° + .3 \times 1000 \times \cos 30°,$$

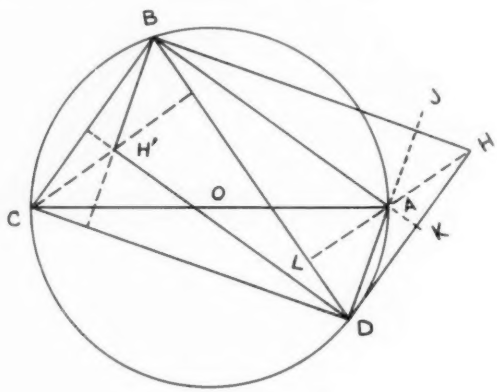
whence $P = 760$ lbs, very nearly. Therefore the block tips.

A solution was also offered by C. W. Trigg, Los Angeles, Calif.

2505. *Proposed by Leon Bankoff, Los Angeles Calif.*

Solution by the Proposer

The diameter AC of a circle ($\bigcirc$) is one of the diagonals of a cyclic quadrilateral $ABCD$. If H, H' are the orthocenters of triangles ABD, BCD respectively, show that quadrilaterals $BH'DH$ and $ABCD$ are congruent.



Solution: Let $\measuredangle A > \measuredangle C$, and let J, K, L denote the feet of the perpendiculars from A upon HB, DH, BD.

BK is $\perp BC$ and to HD.

Hence $HD \| BC$.

JD is $\perp CD$ and to BH.

Hence $CD \| BH$.

So $BCDH$ is a parallelogram, and $BC = HD$; $CD = BH$, and triangles BDH and BCD are congruent (s.s.s.).

Now BK is $\perp HD$ and DH' is $\perp BC$, and since $HD \| BC$, we have $H'D \| BA$.

Also $JD \perp BH$ and $BH' \perp CD$, and since $BH \| CD$, we have $BH' \| AD$.

So $BH'DA$ is a parallelogram, and triangles $BH'D$, BDA are congruent.

It follows that quadrilaterals $ABCD$ and $BH'DH$ are congruent.

Solutions were also offered by C. W. Trigg, Los Angeles Calif.; and W. R. Talbot, Jefferson City, Mo.

2506. *Proposed by Dwight L. Foster, Florida A. and M. College.*

If the equations

$$ax + by = 1$$
$$cx^2 + dy^2 = 1$$

have only one solution, prove that

$$\frac{a^2}{c} + \frac{b^2}{d} = 1, \qquad x = \frac{a}{c} \quad \text{and} \quad y = \frac{b}{d} \cdot$$

Solution by W. R. Talbot, Jefferson City, Mo.

If the line meets the conic in only one point (x_1, y_1), the line is a tangent. The tangent to the conic is $cx_1x + dy_1y = 1$. Comparing coefficients we have $cx_1 = a$ and $dy_1 = b$ as required. Since (x_1, y_1) lies on the conic,

$$\frac{a^2}{c}+\frac{b^2}{d}=1.$$

Solutions were also offered by William Gamzon, Long Beach, Calif.; Benjamin Greenberg, New York, N. Y.; A. R. Haynes, Tacoma, Wash.; Brother Felix John, Philadelphia, Pa.; J. Byers King, Denton, Md.; C. W. Trigg, Los Angeles, Calif.; Walter R. Warne, St. Petersburg, Fla. and the proposer.

2507. *Proposed by Brother Felix John, Philadelphia, Pa.*

Prove the identity

$$\frac{\sin^4 x+\cos^4 (x+30)+\sin^4 (x+60)}{\sin^2 x+\cos^2 (x+30)+\sin^2 (x+60)}=\frac{3}{4}\,.$$

Solution by A. R. Haynes, Tacoma, Wash.

$$\cos (x+30)=\tfrac{1}{2}(\sqrt{3} \cos x-\sin x)$$
$$\sin (x+60)=\tfrac{1}{2}(\sqrt{3} \cos x+\sin x)$$
$$(a+b)^4=a^4+4a^3b+6a^2b^2+4ab^3+b^4$$
$$(a-b)^4=a^4-4a^3b+6a^2b^2-4ab^3+b^4$$
$$(a+b)^4+(a-b)^4=2(a^4+6a^2b^2+b^4)$$

Now let

$$\sqrt{3} \cos x=a \quad \text{and} \quad \sin x=b \quad \text{and} \quad \cos^2 x=1-\sin^2 x$$

$$\sin^4 x+\frac{2}{2^4}\left[9(1-\sin^2 x)^2+6\cdot 3(1-\sin^2 x) \sin^2 x+\sin^4 x\right]=\sin^4 x+\frac{9-8 \sin^4 x}{8}=\frac{9}{8}$$

$$\sin^2 x+\frac{1}{4}\left[3\cos^2 x+2\sqrt{3} \cos x \sin x+\sin^2 x+3 \cos^2 x-2\sqrt{3} \cos x \sin x+\sin^2 x\right]$$

$$=\sin^2 x+\frac{6-4 \sin^2 x}{4}=\frac{3}{2}$$

$$\therefore \quad \text{the fraction}=\frac{\frac{9}{8}}{\frac{3}{2}}=\frac{9}{8}\times\frac{2}{3}=\frac{3}{4}$$

Solutions were also offered by Benjamin Greenberg, New York, N. Y.; J. Byers King, Denton, Md.; W. R. Talbot, Jefferson City, Mo.; C. W. Trigg, Los Angeles, Calif.; and the proposer.

2508. *Proposed by Brother Felix John, Philadelphia, Pa.*

In triangles ABC and $A'B'C'$, angles C and C' are supplementary, and sides c and c' are equal. If the perimeters of the triangles are equal, find the ratio of their areas.

Solution by the Proposer

1.

$$K=\tfrac{1}{2}ab \sin C \quad \text{and} \quad K'=\tfrac{1}{2}a'b' \sin C'.$$

Then,

$$K/K'=ab/a'b'.$$

2. Let $2s=$ the perimeter of each triangle, so that

$$2(s-c)=a+b=a'+b'.$$

3. By the Law of Cosines,

$$\cos C=(a^2+b^2-c^2)/2ab \quad \text{and} \quad \cos C'=(a'^2+b'^2-c^2)/2a'b'=-\cos C.$$

4. Then

$$(a'^2+b'^2-c^2)/2a'b'=(c^2-a^2-b^2)/2ab.$$

5. By the rule of addition in proportion,

$$(a'+b'+c)(a'+b\ -c)/a'b'=(c+a-b)(c-a+b)/ab.$$

6.

$$s(s-c)/a'b'=(s-b)(s-a)/ab$$

or

7.

$$a'b'=\text{abs}(s-c)/(s-a)(s-b).$$

8. Substituting this value in the first step,

$$K/K'=(s-a)(s-b)/s(s-c) \text{ which}=\tan^2 \tfrac{1}{2}C:1.$$

Solutions were also offered by Benjamin Greenberg, New York, N. Y.; W. R. Talbot, Jefferson City, Mo.; C. W. Trigg, Los Angeles, Calif.; and Walter R. Warne, St. Petersburg, Fla.

PROBLEMS FOR SOLUTION

2527. *Proposed by Benjamin Greenberg, New York, N. Y.*

Solve:

$$x+1=y$$

$$x^y+y^x=17.$$

2528. *Proposed by Brother T. Brendan, St. Mary's College, Calif.*

Check this statement: "If there are more trees than there are leaves on any one tree, then there exist at least two trees with the same number of leaves."

2529. *Proposed by J. W. Lindsey, Amarillo, Texas.*

Find the volume of the largest sphere that can be cut from a cone of revolution 14 inches high and 12 inches in diameter.

2530. *Proposed by Julius Sumner Miller, El Camino, Calif.*

A man of mass M stands on a platform of mass m. He pulls on a rope which is fastened to the platform and which runs over a pulley on the ceiling. With what force must he pull to give himself and the platform an upward acceleration a?

2531. *Proposed by Brother Felix John, Philadelphia, Pa.*

Show that $3^{2n+5}+160n^2-56n-243$ is divisible by 512.

2532. *Proposed by Anthan Altshiller-Court, University of Oklahoma.*

Find the length (in terms of the sides) of the segment determined on a side of a triangle by the bisectors of the angles formed by the median relative to that side and the parallel to that side through the opposite vertex.

STUDENT HONOR ROLL

The Editor will be very happy to make special mention of classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each student contributor will receive a copy of the magazine in which his name appears.

For this issue the Honor Roll appears below.

2505. *Ronnie Stamm, Wisconsin High School, Madison, Wis.*

2507. *Richard Kerslake and Henry L. W. Nuttle, Caroline High School, Denton, Md.*

2507. *Charles W. King, Washington College, Chesterton, Md.*

BOOKS AND PAMPHLETS RECEIVED

LOGIC AND SCIENTIFIC METHODS, AN INTRODUCTORY COURSE, by Herbert L. Searles, *Professor of Philosophy, University of Southern California, Los Angeles, California.* Second Edition. Cloth. Pages viii+378. 13.5×21 cm. 1956. The Ronald Press Company, 15 E. 26th Street, New York 10, N. Y. Price $4.25.

ALGEBRA, BOOK ONE, by A. M. Welchons, W. R. Krickenberger, and Helen R. Pearson, *The Arsenal Technical High School, Indianapolis, Indiana.* Revised Edition. Cloth. Pages xi+580. 15×23 cm. 1956. Ginn and Company, Statler Building, Boston 17, Mass. Price $3.28.

BETWEEN THE PLANETS, by Fletcher G. Watson, *Associate Professor of Education at Harvard.* Revised Edition. Cloth. Pages vi+188+40. 15×23.5 cm. 1956. Harvard University Press, Cambridge, Mass. Price $5.00.

THE WORLD OF ATOMS, AN INTRODUCTION TO PHYSICAL SCIENCE, by J. J. G. McCue, *Formerly Associate Professor of Physics, Smith College.* Cloth. Pages xiii+659. 15×23 cm. 1956. The Ronald Press Company, 15 E. 26th Street, New York 10, N. Y. Price $6.50.

THE THREE R'S PLUS, edited by Robert H. Beck, *Professor of the History and Philosophy of Education, University of Minnesota.* Cloth. Pages x+392. 14.5×23 cm. 1956. University of Minnesota Press, Minneapolis 14, Minn. Price $5.00.

ALGEBRA, FIRST COURSE, by John R. Mayor and Marie S. Wilcox. Cloth. Pages viii+392. 15×22.5 cm. 1956. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $3.08.

HI-FI LOUDSPEAKERS AND ENCLOSURES, by Abraham B. Cohen, *Engineering Manager, University Loudspeakers, Inc.* Leather Finish Marco Cover. Pages vii+360. 14×22 cm. 1956. John F. Rider Publisher, Inc., 480 Canal Street, New York 13, N. Y. Price $4.60.

ELECTRONICS, by A. W. Keen, M.I.R.E., A.M.I.E.E., *Lecturer of Electronics and Telecommunications at Coventry Technical College.* Cloth. 256 pages. 13.5×20.5 cm. 1956. The Philosophical Library, Inc., 15 E. 40th Street, New York 16, N. Y. Price $7.50.

CHEMISTRY IN ACTION, by George M. Rawlins, *Professor of Chemistry, Austin Peay State College, Clarksville, Tennessee;* and Alden H. Stuble. *Late Teacher of Chemistry, Western High School, Washington, D. C.* Third Edition. Cloth. Pages viii+591. 15.5×23.5 cm. 1956. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $4.40.

DIFFERENTIAL EQUATIONS, by Harry W. Reddick, *Visiting Professor of Mathematics, Syracuse University,* and Donald E. Kibbey, *Professor of Mathematics, Syracuse University.* Third Edition. Cloth. Pages ix+304. 13.5×21.5 cm. 1956. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $4.50.

FUNDAMENTAL MATHEMATICS, by Thomas L. Wade, *Professor of Mathematics, The Florida State University,* and Howard E. Taylor, *Associate Professor of Mathematics, The Florida State University.* Cloth. Pages xiv+380. 14.5×23 cm. 1956. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 36, N. Y. Price $4.75.

ANALYTIC GEOMETRY, by R. S. Underwood, and Fred W. Sparks, *Texas Technological College*. Second Edition. Cloth. Pages x+282. 14×21.5 cm. 1956. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price $3.25.

THE SCRIBNER ARITHMETIC BOOKS, 3, 4, 5 AND 6, by Richard Madden William A. Gager, and Leslie S. Beatty. Book 3, 328 pages. Book 4, 327 pages. Book 5, 327 pages. Book 6, 343 pages. Book 7, by William A. Gager, Beluah Echols, Carl N. Shuster, Richard Madden, and Franklin W. Kokomoor. Pages viii+390. Book 8, by William A. Gager, Dorris H. Johnson, Carl N. Shuster, Richard Madden, and Franklin W. Kokomoor. Pages viii+373. Each Cloth. 15×21.5 cm. 1955. Charles Scribner's Sons, 597 Fifth Avenue, New York 17, N. Y. Books 3, 4, 5, 6 are $2.12. Books 7 and 8 are $2.24.

TEACHER'S GUIDE AND ANSWERS FOR THE SCRIBNER ARITHMETIC, BOOK 3, by Richard Madden, Leslie S. Beatty, and William A. Gager. Paper. 185 pages. 23×30 cm. 1956. Charles Scribner's Sons, 597 Fifth Avenue, New York 17, N. Y. Price $1.80.

THE RADIO AMATEUR'S HANDBOOK, by The Headquarters Staff of the American Radio Relay League. 33rd Edition. Paper. 760 pages. 16×24.5 cm. 1956. American Radio Relay League, West Hartford 7, Conn. Price $3.00.

INTRODUCTION TO COLOR TV, by Milton Kaufman, *Engineer, Color Engineering Labs, CBS—Columbia*, (A Division of Columbia Broadcasting System); and Harry E. Thomas, *Senior Project Engineer, Federal Telecommunication Labs., Inc.* (A Division of I.T.&T.). Second Edition. Paper. Page iv+156. 14×21.5 cm. 1956. John F. Rider, Publisher, Inc., 480 Canal Street, New York 13, N. Y. Price $2.70.

MULTIVIBRATORS, Edited by Alexander Schure, Ph.D., Ed.D. Paper. Pages iv+48. 14×21.5 cm. 1956. John F. Rider, Publisher, Inc., 480 Canal Street, New York 13, N. Y. Price 90 cents.

BOOK REVIEWS

DICTIONARY OF NEW WORDS, by Mary Reifer. Cloth. Pages ix+234. 13.5×21 cm. 1955. Philosophical Library, Inc., 15 East 40th Street, New York, N. Y. Price $6.00.

How often have you been reading your daily paper and come across OES or BW or HOLC and wondered what it was all about? Or, if not a military man, have you seen the expression "hershey bar," "hit the silk," or "MAD-Bird" and had no idea of the meaning? This book is filled with such expressions and hundreds of other types not found in the latest modern dictionary. "Allophone," "balun," and "cosmotron" are in other fields. This book will extend your vocabulary and help you to understand what is being said all around you. The book probably does not include every new word or expression, because if it did when it was written just a few months ago, it would not include all in use now, but it will greatly increase your understanding of much that you now hear and read in the newspapers, magazines, and late books of fiction or history. For this alone it is certainly worth the price.

G. W. W.

THIS WORLD OF OURS, by Abram Glaser, *College of the City of New York*. Cloth. Pages xiii+492. 13×20.5 cm. 1955. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $5.00.

On the cover page we find these statements: " . . . a work which we believe will furnish the average person with a coherent outlook on most fundamentals that make up 'this world of ours.' He deals deftly with the physical, vital, and

psychic forces in the world, the human body, man's mental progress, world literature and religions, and things political, economic, and legal." From the Preface we quote: "The following pages comprise what I consider basic in respect to both the physical aspects of the world and world culture and development."

Let us examine the book to find out what *we* believe with respect to its contents. A careful reading reveals a book interesting throughout. If we know nothing about the author, not even his name, we would at once recognize it as "a correlated framework of essential knowledge." (Probably we would say "of *some* essential knowledge.") The author has traveled far and for many years, seeking an understanding of the people of all lands. Here he has tried to put together in brief form something that will assist "the hearts and minds of men to attain the greatest good for the greatest number." Let us summarize what he has produced. He starts with some interesting facts of astronomy: what the great Mt. Wilson telescope shows, the evolution of stars, the expanding universe. Here we find the orbit of Pluto stated as several billion miles from the sun—a correct statement if by *several* billion we mean about *four- and one-half* billion at maximum. A few more pages completes the discussion of the entire field of astronomy, 17 pages in all. 13 pages follow in the field of physics and chemistry; 16 pages on the origin of life and forces that control it. The human body gets 16 more, psychic forces 20, and the development of thought, 30. Here we find that Professor Roentgen, of *France*, discovered X-Rays. Then follows 158 pages on "Human Relations in World Literature," fairly equally divided between quotations and the author's comments on the quotations, their authors, and the time and history of their production. Religious development is covered in 75 pages for all religious beliefs and selected quotations from the religious books. Political development follows with 43 pages, economic development with 28 pages. 22 pages more on the satisfaction of demands by law, and a closing 14 pages entitled, "This I Believe."

It is evident that the author has limited knowledge and understanding of the great influence of science on the entire field of world development. All the progress of world development produced by investigations in physics, chemistry, and biology is rushed over in a few pages; mathematics does not seem to exist. The book is well written in excellent language, is interesting throughout, but it fails to say much about the most essential things effective in developing "This World of Ours."

G. W. W.

Dictionary of Mechanical Engineering Terms, originally compiled by J. G. Horner, A.M.I.M.E. Seventh Edition Revised and Enlarged by Staton Abbey. Cloth. Pages iv+417. 12×18.5 cm. 1955. Philosophical Library, Inc., 15 East 40th Street, New York 16. N. Y. Price $6.50.

For those not acquainted with previous editions of this book it may be well to say that Mr. Horner put out a book which included much more than an ordinary dictionary. It was more in the nature of what might be classed as a condensed encyclopedia of mechanical engineering. In recent years engineering, like all other science subjects, has taken on many new terms, especially in the fields bordering on metallurgy, electricity, electronics, radiology, and other subjects closely related to physics. This introduced a vast addition to the engineering vocabulary. The Seventh Edition is designed to cover all these new terms, bringing the dictionary completely up to date. It is divided into two sections: Part I, the Dictionary of Modern Terms Used in Mechanical Engineering, and Part II, the Dictionary of General and Traditional Terms Used in Mechanical Engineering.

G. W. W.

Matter and Light, The New Physics, by Louis De Broglie, *Membre de l'Institut, Nobel Prize Award, 1927, Professeur a la Faculte, des Sciences de Paris.* Paper. 300 pages. 12.5–20.5 cm. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $1.60.

Two statements in the preface forecast the problem and the significance of its solution: "(The past) few decades have witnessed the downfall of (some of) the best established principles and most firmly supported conclusions (of physics)." The optimism of the author counters this report of near-disaster with, "Yet it is fair to observe that the advance made by quantum physics has opened entirely novel perspectives on a great number of questions."

Basically the theorist in physics is struggling with the problem, "Can reality be interpreted in terms of continuity or discontinuity?" Physicists of the nineteenth century had accepted the first interpretation for light phenomena and the second for matter and electricity. Wave continuity answered optical "whys," and corpuscles serve that need for matter and electricity. The author here reports progress, in the New Physics, of a synthesis of those two aspects of reality in the theory of wave mechanics for interpreting both light and matter.

In six sections, many of which have sub-topic offerings, the following are considered: Present day physics (a survey); Matter and electricity (explained by corpuscles); Light and radiation (explained by waves); Wave mechanics (the tool of integration) and Philosophical studies (projecting physical patterns to reality in general.) There are four insertions labelled appendices; a five and a half page double-columned index but no table of contents.

He points out that, within the last fifty years, experimentally precise findings have confronted the theorist with phenomena that are inexplicable by the traditional philosophies of matter and energy. The photo-electric cell; characteristic spectrum radiations for individual atomic species; electron diffraction and interference and black-body radiation have indicated that a wave-aspect of matter's corpuscles may be needed for explanation and for radiation there may be need for a corpuscular quality for its waves. In an effort to bring these ill-fitting facts of matter and radiation into a common frame of reference the theory of wave-mechanics was born. "It led to an interpretation of the laws of physics in terms of probability, an interpretation . . . which seems (now) to be accepted fairly generally. But in spite of that success, the fact that it is essentially nonrelativistic is (somewhat) disconcerting. . . . At the present moment (1937) . . . this reconcilliation (of wave mechanics and relativity) has not been satisfactorily affected."

While the author promises, in his preface, that "the . . . chapters require no mathematics" for this reviewer the vocabulary used frequently became heavily freighted with mathematical implications. Though such reading involves "mental muscle stretching" it warrants the effort by reason of its stress of philosophical implications. Its pages will serve most of its readers in modernizing their traditional physics. However, the date of its appearance (1937) should remind one that this is not the latest word. It would be to the distinct advantage of the teaching of high school physics if its teachers were, one and all, induced to read this book.

B. Clifford Hendricks
Hastings College
Hastings, Neb.

General Chemistry for Colleges, Fifth Edition, by B. Smith Hopkins, *Late Professor of Inorganic Chemistry, University of Illinois* and John C. Bailar, Jr., *Professor of Chemistry, University of Illinois.* Cloth. Pages x+701, 15.9×23.5 cm. 1956. D. C. Heath and Co., 285 Columbus Avenue, Boston 16, Massachusetts. Price $6.00.

This is the fifth edition of a general college chemistry text book that has been widely accepted in its previous editions. Both authors have had many years of enviable success teaching college freshmen. The earliest editions were authored by Professor Hopkins, while this most recent edition has been revised by Professor Bailor.

A glance at the outline of contents indicates that the classical approach has been retained. All principles are clearly stated and the language used is well suited to the average college freshman. Good learning exercises, as well as a

reference list for additional reading, are found at the end of each chapter. The properties of elements and their compounds are explained in terms of electronic structure. The junior author states in his preface: "Effort has been made to explain the 'why' of physical properties and chemical behavior in order to encourage students to understand, rather than to memorize, the principles and facts of chemistry." Considerable emphasis has been placed on modern applications. Such recent topics as the hydrogen bomb, silicones, and iron from taconite are included. Some of the main changes in this edition are a reorganization of the section on organic chemistry and a rewriting of the chapter on nuclear chemistry.

The book is prepared by the publisher in excellent form: good paper, clear type and good binding. This last revision should make for even greater sales of a popular text.

GERALD OSBORN
Western Michigan College
Kalamazoo, Michigan

UHF TELEVISION ANTENNAS AND CONVERTERS, by Allan Lytel, paper. 118 pages. 13.5×21 cm. 1953, John F. Rider Publisher, Inc. 480 Canal Street, New York 13, New York, Cat. No. 153. Price $1.80.

Rider gives assistance to the amateur in this handbook in that technical terms have been kept to a minimum. With so many UHF channels opening up throughout the country it would do well for more TV owners to familiarize themselves with the contents of such a publication. Although hardly more than a hundred pages, the author thoroughly discusses the conversion systems available, their installation, transmission lines, antennas and circuits. More than a dozen individual converters are covered in non-technical detail; this includes single channel and full range types.

A table lists various types of UHF test equipment with models, manufacturers and specifications. There are more than eighty illustrations including photographs and diagrams. In addition to being a reference manual for T-V technicians, this handbook might serve the Physics teacher, hobbyist and the school's Radio Club sponsor.

JOHN D. WOOLEVER
Mumford High School
Detroit, Mich.

TECHNICIAN'S GUIDE TO TV PICTURE TUBES, by Ira Remer, paper. 154 pages. 13.5×21 cm. 1954. John F. Rider Publisher, Inc. 480 Canal Street, New York 13, N. Y. Price $2.40.

This is a limited area TV technician's service guide. It includes only basic information and does not get involved in technical data, formulae or circuit explanations. Neither does it propose to explain theory, but sticks strictly to the immediate serviceman's needs.

There are six chapters revolving about basic picture tube parts, accessories and repair. The final chapter is devoted to quick reference tables and charts. The appendix devotes space to the color tube as if it were an after thought preceding publication deadline. Diagrams and photographs are clear and informative. The author fulfills his objective in limiting his subject and providing a handy guide for both the experienced and inexperienced technician.

JOHN D. WOOLEVER

NEW WORLD OF CHEMISTRY, by Bernard Jaffe, *James Madison High School, New York City*. Cloth. Pages ix+678. 16×23 cm. 1955. Silver Burdett Company, 45 East 17th Street, New York 3, N. Y. Price $4.16.

This third revision of a twenty year old text has had more added to it than a new cover. Although there are fewer pages, many new items have been added. The book is meant to be used for two semesters primarily by college preparatory students, being too "strong" for a "general" non-lab student.

Vocabulary is not too advanced but is suitable and adaptable to the short smooth flowing sentences. There is an excellent historical background with good interpretation. Illustrations are used to help clarify the subject rather than fill space. Sequence of material is logical although the instructor can skip and hop about the chapters to his own purposes without loss to the student. No special lab manual is required as the material fits in nicely with the average lab work.

Theories and new ideas are up to date. Space is devoted to nuclear energy, plastics, photography and hydrocarbons. Science careers are frequently encouraged. Explanations are too wordy in a few cases and unfortunately there is almost no practical home application. The questions are thought provoking but they could have been graduated for progressive thought.

Pictures on the whole are fair, the diagrams colorful, superior. There are few charts or tables. Each of the forty chapters terminates with a descriptive list of books and periodicals on the subject, a summary of major ideas, review questions and laboratory activities. Revision has brought many modern changes to this well known superior text.

JOHN D. WOOLEVER

FAMOUS PROBLEMS OF ELEMENTARY GEOMETRY, by F. Klein; FROM DETERMINANT TO TENSOR, by W. F. Sheppard; INTRODUCTION TO COMBINATORY ANALYSIS, by P. A. Macmahon; THREE LECTURES ON FERMAT'S LAST THEOREM, by L. J. Mordell. Cloth. Pages xi+92+127+viii+71+31. 12.5×20.5 cm. Chelsea Publishing Company, 552 West 181 Street, New York 33, N. Y. Price $3.25.

The combination of books which the publisher has elected to combine into a single volume seems rather unusual in that many readers will be primarily interested in one or at most two. The particular books have not been readily available recently and should certainly be in any college library and would be a valuable addition to any teacher's library.

Klein's work, as revised by R. C. Archibald, is a classic reference on the problems of duplication of the cube, trisecting an angle, and squaring the circle. Many have never seen the proofs given which show why the constructions are impossible under stated conditions. (The individual without some mathematical maturity will not be able to follow all the argument, and may remain unconvinced.)

Although the first two chapters of Sheppard's work are introductory, the remaining material is more advanced. Macmahon's work is likewise advanced beyond the work on permutations and combinations found in the usual college algebra text (for example, the elementary theory of symmetric functions, the multinomial theorem).

The work on Fermat's last theorem shows something of the progress made towards its proof, up to 35 years ago.

The collection is perhaps of greatest importance in that it makes available certain classic works, rather than any statement of the present situation.

CECIL B. READ
University of Wichita

THE THEORY OF GROUPS, by A. G. Kurosh. Translated from the Russian and Edited by K. A. Hirsch. Volume One. Cloth. 272 pages. 14.5×23 cm. 1955. Chelsea Publishing Company, 552 West 181 Street, New York 33, N. Y. Price $4.95.

This is a translation of a Russian text which first appeared in 1940, and in a second edition in 1952. In the translator's preface he states the work " . . . has been widely acclaimed as the first modern text on the general theory of groups."

The book requires considerable mathematical maturity, and specifically, knowledge of congruences, matrices, combinations, set theory. It is probably usable as a graduate text; even then some instructors will object to the absence of exercises. The individual trying to read the work independently will find difficulty in several places.

The publishers are to be complimented on the typography; the pages are very readable.

There is a rather extensive bibliography, including over 500 items.

CECIL B. READ

THE REAL PROJECTIVE PLANE, Second Edition, by H. S. M. Coxeter, *Professor of Mathematics, University of Toronto.* Cloth. Pages xi+226. 13.5×21.5 cm. 1955. Cambridge University Press, 32 East 57th Street, New York 22, N. Y. Price $4.75.

This is the second edition of a text first published in 1949. It is intended for a first course in projective geometry, requiring no background beyond secondary school algebra and geometry (although more mathematical maturity is certainly to be desired). The treatment is primarily synthetic and should be classified as traditional. Although courses in projective geometry seem to be less frequently offered than a generation ago, the subject is by no means extinct. There is more material than would normally be included in a one semester course. Problems seem in some places to be rather limited in number. The last two chapters provide an introduction to the analytic treatment, a two page appendix discusses very briefly the complex projective plane.

CECIL B. READ

EXPERIMENTAL DESIGN, by Walter T. Federer, *Professor of Biological Statistics in Charge of the Biometrics Unit, Department of Plant Breeding, New York State College of Agriculture, Cornell University, Ithaca, N. Y.* Cloth. Pages xix+544 +47. 15×23.5 cm. 1955. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $11.00.

Not everyone, in particular the authors of other books, will agree with the statement that no other single text suffices entirely for a course in the design of experiments—it depends on what is to be the content of the course. This text is, however, much more comprehensive than any which has come to the reviewer's attention.

The reader will need both mathematical and statistical maturity (if indeed these do differ!) to profitably follow the text; as a single statistical example one finds the discussion of null hypothesis, type I and type II errors, tests of significance, and power of a test discussed in about one and a fourth pages. Mathematical background necessary would certainly include integral calculus and differential equations as well as a good knowledge of matrices; in spite of the statement in the preface that material on variance component analysis can be handled with only college algebra, it will be only the exceptional student who can get along with this minimum.

There are several tables not readily available elsewhere, certainly not in a single publication; other material may be of value to those analyzing experiments for a single example, the relationship between chi-square, Fisher's z, Student's t, and Snedecor's F.

There are many illustrative examples, with detailed analyses, which could serve as models; problems for solution and "literature citations" are furnished for the chapters following III (the first three chapters discuss the design of experiments).

The typography is good—there is an intermingling of printed material and reproduction of typed material which probably is necessitated by the nature of the material.

Some instructors may feel the material included is far more than could be covered in a first course; the author suggests selections for courses of different levels, his suggestions seem feasible. Instructors in fields other than agriculture may wish that illustrative examples had been selected from other fields (casual checking shows only two outside of the general field of "agriculture": examples VII-2 and XIV-2). Even if not acceptable as a text, the work should be excep-

tionally valuable as a reference and working guide. The extent of coverage is partially indicated by a bibliography of 340 items—these are items actually cited in the book, not merely articles or books which are pertinent.

CECIL B. READ

TRIGONOMETRICAL SERIES, by Antoni Zygmund. Paper. 352 pages. 12.5×20.5 cm. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price, $1.85.

The publishers point out that this is an unabridged republication of the edition published in 1935. The material is rather complete on the topic of Fourier's series, and will require considerable mathematical maturity to follow. Certainly one needs knowledge of functions of a complex variable, likewise of infinite series and of matrices.

Although there are selected examples at the end of each chapter, the book is probably better classified as a reference work than an elementary text. There is a bibliography of approximately 300 references (all prior to 1935). This reprint makes the work available at a modest price.

CECIL B. READ

PARTIAL DIFFERENTIAL EQUATIONS OF MATHEMATICAL PHYSICS, by Arthur Gordon Webster, A.B. (Harv.), Ph.D. (Berol.) Paper. Pages vii+440. 12.5×20.5 cm. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $1.85.

Although the title covers the main objective of the work, there are many concise summaries of varied topics in mathematics. To mention only a few, in the first few pages one encounters analytic functions, continuity, vector analysis; somewhat further along are such topics as Fourier's Series, integral equations, Dirichlet's integral, the probability integral, spherical harmonics, Bessel functions; the appendix considers Jacobians, uniform convergence, definite integrals, complex variables, linear differential equations.

When one considers that these mathematical topics and many more are applied to a very wide range of physical problems, it seems obvious that a reference work of no small value must result. There are essentially no problems for solution, the reading of the material requires considerable maturity in both mathematics and physics.

Those who have wished to add this book to a library will be pleased to find it available at the low price.

CECIL B. READ

CARL FRIEDRICH GAUSS: TITAN OF SCIENCE. A STUDY OF HIS LIFE AND WORK, by G. Waldo Dunnington, Ph.D., *Member of the Faculty of Northwestern State College, Natchitoches, Louisiana.* Cloth. Pages xi+479. 13×20 cm. 1955. Exposition Press, 386 Fourth Avenue, New York 16, N. Y. Price $6.00.

As an undergraduate student, this reviewer had the privilege of talking with a grandson of Carl Friedrich Gauss, who wondered why someone had not made use of available information concerning his famous ancestor. Professor Dunnington's work certainly shows the result of years of study, and seems an exhaustive work which is a valuable addition to the history of mathematics. It is probable that the book will be of more value in this sense than as a "popular" biography. First of all, the reader must have some knowledge of advanced mathematics to follow the discussion in several places; again, the writing seems to lean more on the side of a scholarly dissertation than that of a "book club selection"; in a few places repetition of minor details seems to slow down the story.

In general the work greatly supplements available information. (The author's claim that Gauss was the first to use the symbol i is not in agreement with the statement in Cajori's *History of Mathematics* that this was used earlier by Euler.) Certain items of Gauss' boyhood are here stated as facts, without any qualification—perhaps the author's research has clearly placed these outside the

realm of possible legend or fabrication. Examples are the oft quoted story of how the young Gauss used the formula for the sum of the integers from 1 to 100, rather than performing the addition; the story of the three-year-old Gauss detecting an error in calculating the pay for one of his father's workmen.

The appendix lists among other items a genealogical table for seven generations; courses he taught; books he borrowed from the university library as a student; his publications; and an excellent bibliography of books and articles about Gauss.

Many will want this book for a private library, certainly no college or university library could afford not to have it on their shelves. Every page of the work bears evidence of long and careful study. The reviewer feels, and he believes the grandson mentioned earlier would likewise feel that here there is a worthy tribute to a great mathematician as well as a detailed record of his life.

CECIL B. READ

AIRCRAFT TODAY, edited by John W. R. Taylor. Cloth. 96 pages. 18×24 cm. 1956. Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $4.75.

This very interesting book consists of 13 articles on various subjects related to the many phases of aviation. It is the second edition of a book compiled and edited by a British writer. It is written primarily about aircraft and aviation of Great Britain. But at many places they compare their aircraft with ours, and speak of the interrelationships of the testing and construction programs of the two countries.

The articles are interestingly written so that this book should have an excellent circulation in any junior or senior high school library. A list of some of the section headings will give you an excellent idea of the contents of the book. Some of these are: "Review of World Aviation"; "Build Yourself an Aeroplane"; "What Do We Know About Russian Aircraft?"; "Camera in the Clouds"; "Shortening the Take-off" and "The Future of Military Air Transport." Each of the articles is profusely illustrated.

E. WAYNE GROSS
University School
Bloomington, Indiana

FUNDAMENTALS OF TRANSISTORS, by Leonard M. Krugman, B.S., M.S., P.E., *Signal Corps Engineering Laboratories.* Paper. 144 pages. 13.5×21.5 cm. 1954. John F. Rider Publisher, Inc., 480 Canal Street. New York 13, N. Y. Price $2.70.

Many books on technical subjects are either too elementary or too advanced to fill the needs of individuals having fundamental knowledge of a subject. This little book fills this requirement. The first two chapters cover semi-conductor physics and description of transistors and their operation. Chapters three and four discuss the types of transistor circuits. The last three chapters are devoted to the circuitry of transistors as amplifiers, oscillators, their use in high frequency devices and various other applications. Comparisons in parameters, performance and function, with respect to vacuum tubes are given which is of great help to those already familiar with tube operations. The book has adequate graphs, illustrations and solved problems. It seems that the value of the problems and illustrations would be enhanced if specific types or identification of the transistors discussed would have been given instead of using general descriptive terms. There are too few books of this quality at this level available.

L. C. WARNER
Wilbur Wright College
Chicago, Ill.

ENJOYING HEALTH (second edition), by Evelyn G. Jones, *Supervising Teacher in Department of Instruction, Denver Public Schools.* Cloth. Pages xii+434.

16.5×22 cm. 1956. J. B. Lippincott Company, New York. No price given.

This text in health, like its companion volume (*Building Health*), has been written to capitalize upon the interests of high school boys and girls. From research studies and many interviews, the fields of health education are made meaningful.

The book is divided into four units, each of which gives opportunity for concentrated study of related health facts, and, at the same time, is a guide for carrying on classwork. The picture previews of each chapter stimulate the interest and pinpoint the attention to the details given in the following pages. Since health classes must have more than discussion, if the instruction is to affect the behavior of pupils, a variety of activities is suggested—the use of the panel, the health council, the pre-med club, and excellent visual aids. The drawings (the work of a medical artist) help pupils to visualize themselves in the situations depicted. Illustrations are modern and up-to-date in dress, attire, and expression. Underneath these are excellent explanatory captions. The author overcomes the problems of scientific vocabulary with "on the spot" definitions. The testing procedure is arranged to provide the teacher with excellent helps. Several forms of tests are used so that the teacher may have samples of a number of ways of constructing health tests.

DOTTY L. LACKEY
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BUILDING HEALTH (second edition), by Dorothea M. Williams, *Cole Junior High School, Denver, Colorado.* Cloth. Pages xii+430. 16.5×22 cm. 1956. J. B. Lippincott Company, Chicago. No price given.

This textbook for use in Junior High School is exactly what its title implies—a program for the building of good health habits and practices in the lives of teenagers. Its premise is laid on the proposition that health is "dependent upon a way of living" as well as the outgrowth of a teaching unit in the curriculum. Three objectives are stressed throughout the book: 1) a human being is a single functioning unit; 2) each individual has his own rate of growth; 3) the challenge of personal responsibility in building correct health habits so that the individual may grow normally and take his place as a healthy and happy member of society.

In its make-up, this text provides a "problem approach" that should be appealing to the teenager. This age student has unlimited questions and wants reasonable solutions to their problems. In this attempt at solution, the book does an excellent job in training the reader to experiment and evaluate before forming conclusions. The section entitled "Looking Ahead" at the beginning of each chapter suggests the steps the teacher and class will take as they explore and seek answers to the questions on that phase of health. Another valuable component of the book is the annotated list of additional reading material for further exploration on the use of resource materials.

The book is profusely illustrated with very clear and appropriate pictures. In a few places the vocabulary might give an unassisted student difficulty, but that is one of the functions of the teacher to help in such cases.

DOTTY L. LACKEY

Twinkle Lamp provides firefly-like lighting effect for indoor or outdoor parties. The scintillating colored lighting is emitted from a self-flashing lamp the size of the smallest Christmas bulb. Available in red, yellow, green and blue, the bulb is designed for use in transformer-operated string sets.

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THE INDUSTRIAL COUNCIL

The Industrial Council is a non-profit educational organization sponsored jointly by Rensselaer Polytechnic Institute and American Industry. Its aim is to provide the social studies teachers of our secondary schools an opportunity to meet informally—in friendly surroundings—with the leaders of our basic industries so that both of these important segments of our society—through an exchange of ideas—can more readily understand and appreciate each other's problems and goals. In this way, the teachers are able to inform their students of the role of American Industry in our society and its value to our economy and to our way of life.

Each year a three day session devoted to the study of a basic American Industry is held on the Rensselaer Polytechnic Institute Campus. To each session, 650 secondary school social studies teachers are invited, as guests, to meet the "statesmen" of the industry to which the particular session is devoted.

The educator guests, representing all 48 states, are recommended by state commissioners of education and local superintendents of schools as leaders in the secondary school social studies field. The number of educator guests invited from each state is determined on a quota basis according to population. A new group of educators is invited to each session except for approximately 10 per cent who are reinvited from the previous meeting for continuity purposes at the discretion of The Industrial Council. The combined attendance of educators and industry representatives at each session comes to over 1,000.

To date, over 5,000 educators and industrialists have attended sessions of The Industrial Council. Founded in 1952, there have been five Council Sessions sponsored, in turn, by

The Oil Industry
The Chemical Industry
The Electrical Manufacturing Industry
The Automotive Industry
The Pharmaceutical Industry